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Aquatic Baseline Ecological Risk Assessment

Ely Copper Mine Superfund Site
Vershire, Vermont

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TABLE OF CONTENTS

FIGURES

ATTACHMENTS

EXECUTIVE SUMMARY

SECTION 4.0

SECTION 5.0

SECTION 6.0

SECTION 7.0

SECTION 8.0

APPENDICES

EXECUTIVE SUMMARY

E.1 INTRODUCTION

A Baseline Ecological Risk Assessment (BERA) was performed on the aquatic habitats potentially affected by the Ely Copper Mine Superfund Site, located in Vershire, VT. The Site was used in the 19^{th} and early 20^{th} century for ore mining, ore "roasting", copper smelting, and disposal of waste rock and tailings. Past site investigations showed severe impacts associated with Acid Mine Drainage (AMD) to terrestrial habitats at the Site and to aquatic habitats on and off the Site.

The major aquatic habitats at the Site consisted of several small ponds (ponds 2 to 5) located on the east branch of Ely Brook (note: pond 1, the furthest upstream - and largest - of the five ponds, was used as a reference location), and the main stem of Ely Brook itself. Several other Ely Brook tributaries had surface water high in acidity and metals but were too small and/or ephemeral to be considered viable aquatic habitats. The major off-Site aquatic habitats consisted of Schoolhouse Brook downstream of the confluence with the main stem of Ely Brook, and the east branch of the Ompompanoosuc River (EBOR) downstream of the confluence with Schoolhouse Brook.

E.2 RISK ANALYSIS

A Screening-Level Ecological Risk Assessment (SLERA) was performed in 2007 using available surface water and sediment analytical data. It identified many inorganic Contaminants of Potential Ecological Concern (COPECs) in all of the aquatic habitats at and downgradient of the Site. This finding prompted the Environmental Protection Agency (EPA) to proceed with a BERA to further determine the degree and extend of ecological risk in these habitats.

The Conceptual Site Model (CSM) developed for the SLERA was expanded to identify the likely exposure pathways and receptors in the aquatic habitats on- and off-Site. The receptor groups of concern were benthic invertebrates, water column invertebrates, fish, amphibians, insectivorous birds and mammals, and piscivorous birds and mammals.

Not all receptor groups were assessed for ecological risk in all habitats. For example, fish were absent from the ponds. The ponds and the main stem of Ely Brook were also considered to provide too small a habitat for insectivorous birds and mammals. Exposure routes included direct exposures to COPECs in bulk sediment, pore water, and/or surface water by aquatic receptors (invertebrates, fish, and amphibians), and ingestion of contaminated surface water and winged aquatic insects and fish by insectivorous and piscivorous wildlife receptors.

The CSM formed a basis to select assessment endpoints and measurement endpoints. The assessment endpoints were explicit expressions of key ecological resources to be protected from harm associated with releases of AMD to the ponds and the on- and off-Site waterways. The assessment endpoints used in the BERA were as follows:

- **A stable and healthy benthic invertebrate community**: *Are the COPEC levels in sediment sufficiently high to cause biologically-significant changes or impair the function of the benthic invertebrate community in the four ponds and the three streams at and down-gradient from the Site?*

- **A stable and healthy water column invertebrate community**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the water column invertebrate community in the four ponds at the Site?*

- **A stable and healthy fish community**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the fish* *community in the three streams at and down-gradient from the Site?*

- **Stable and healthy amphibian populations**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the amphibian populations in the four ponds at the Site?*

- **Stable and healthy insectivorous bird populations**: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

- **Stable and healthy insectivorous mammal populations**: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous mammal populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

- **Stable and healthy piscivorous bird populations**: *Are the COPEC levels in surface water and biota sufficiently high to impair piscivorous bird populations foraging in Schoolhouse Brook and the EBOR?*

- **Stable and healthy piscivorous mammal populations**: *Are the COPEC levels in surface water, sediment, and biota sufficiently high to impair piscivorous mammal populations foraging in Schoolhouse Brook and the EBOR?*

It was not possible to directly quantify the risk to these assessment endpoints. Instead, several measurement endpoints were selected for this purpose. These endpoints were measurable ecological characteristics, quantified through laboratory or field experimentation, which could be related back to the valued ecological resources chosen as the assessment endpoints. The measurement endpoints represented the same exposure pathways and mechanisms of toxicity as the assessment endpoints to which they were related.

The following seven types of measurement endpoints were used in the BERA:

- Compare COPEC levels in sediment, pore water, and surface water samples to published sediment or surface water benchmarks.
- Assess the bioavailability of divalent metals in sediment samples by measuring the Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM).
- Perform toxicity tests in the laboratory by exposing sensitive life stages of aquatic invertebrates and fish to sediment, pore water, and surface water samples from the waterways.
- Perform toxicity tests in the ponds by exposing wood frog eggs and tadpoles kept in floating cages.
- Compare the COPEC levels in whole fish collected from the waterways to literature-derived Critical Body Residues (CBRs).
- Quantify the structure and function of the benthic invertebrate community and fish community in the waterways.
- Use food chain modeling to calculate an Estimated Daily Dose (EDD) to insectivorous and piscivorous wildlife receptors from exposure to surface water and aquatic biota (winged aquatic insects and fish); compare these EDDs to Toxicity Reference Values (TRVs) from the literature.

The various measurement endpoints used in this BERA varied in their ability to quantify the risks to their related assessment endpoints. Some of the measurement endpoints were quite generic (e.g., sediment or surface water benchmarks), whereas others were highly quantitative and reflected long-term, site-specific impacts at a higher level of ecological organization (e.g., community surveys). To support risk characterization, each measurement endpoint was provided with a descriptive Weight-of-Evidence (WOE) score which ran from “low” to “high”. The final risk integration step included this score to determine the potential for and significance of the potential for risk to the various assessment endpoints.

Specific Exposure Units (EUs) were defined for each assessment endpoint. The EUs consisted of the ponds 2 to 5 on the east branch of Ely Mine, the main stem of Ely Brook downstream from where AMD reaches the brook, Schoolhouse brook from the confluence with the main stem of Ely Brook to its confluence with the EBOR, and the EBOR below the confluence with Schoolhouse Brook. These EUs were needed to determine how to summarize the analytical data into specific data sets for use in the risk calculations.

Each EU had an associated “reference” EU which was not affected by AMD but resembled the impacted EUs in all other respects. For example, the reference EU for Schoolhouse Brook was a stretch of this brook located just upstream of where the main stem of Ely Brook enters Schoolhouse Brook. The reference EUs served to quantify the risks associated with local reference levels of COPECs.

EU-wide Central Tendency Exposures (CTEs) were calculated based on arithmetic means, and Reasonably Maximum Exposures (RMEs) were calculated based either on the COPEC-specific 95th percentile Upper Confidence Limit (UCL) or the maximum concentration.

Where appropriate, the potential for ecological risk was determined based on Hazard Quotients (HQs). An HQ was calculated for each COPEC by dividing an exposure or dose by a corresponding toxicity value (i.e., published benchmarks, CBRs, or TRVs). Statistics were also used to determine the presence of risk identified by the toxicity tests and community surveys.

During risk characterization, all HQ-derived risks at the on- or off-Site waterways were compared to their corresponding risk at the reference EU by calculating an Incremental Risk (IR). The IR was obtained by subtracting the reference risk from the Site risk. The presence of risk was deemed unrelated to past Site activities if the reference risk exceeded the Site risk. This approach allowed for a more thorough and accurate assessment of Site-related impacts by factoring in reference COPEC levels.

E.3 GENERAL CONCLUSIONS OF THE BERA

Attachments E.1 to E.8 provide the WOE risk integration by receptor group across the various aquatic habitats evaluated in the BERA. **Attachments E.9 to E.15** summarize the general conclusions on the ecological risk potential for each aquatic habitat. Additional details are provided below.

E.3.1 Benthic invertebrate community

The potential for ecological risk to the benthic community exposed to Site-related contamination was assessed in all of the aquatic habitats using up to six measurement endpoints (depending on the target habitat), as follows:

- Compare COPEC concentrations in bulk sediment samples to sediment benchmarks (the four ponds, main stem of Ely Brook, Schoolhouse Brook, and the EBOR)
- Compare dissolved COPEC concentrations in sediment pore water samples to surface water benchmarks (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Estimate the bioavailability of divalent metals in sediment based on AVS - SEM (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in two benthic invertebrate species exposed for 96 hours to sediment pore water samples (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in two benthic invertebrate species exposed for 10 and 28 days to bulk sediment samples (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Evaluate the structure and function of the invertebrate community in the field (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).

E.3.1.1 The ponds on the east branch of Ely Brook

Bulk sediment chemistry was the only measurement endpoint available to assess risk to these four aquatic habitats. Severe ecological risk to the benthic invertebrate community was expected in pond 5, based on high Cu concentrations. Ponds 3 and 4 could experience minor ecological risk due to small exceedances of Mn (pond 3) and Cu (pond 4). No risk was expected in pond 2. The reliability of these findings is low because it is based on a single, semi-qualitative LOE.

E.3.1.2 The main stem of Ely Brook

All six measurement endpoints indicated the potential for ecological risk to the benthic invertebrate community in the main stem of Ely Brook. This conclusion was supported by the three “chemical” Lines of Evidence (LOEs) (i.e., comparing sediment COPEC levels to benchmarks, comparing pore water COPEC levels to benchmarks, and assessing sediment divalent metal bioavailability based on AVS – SEM) and the three “biological” LOEs (i.e., pore water toxicity testing, bulk sediment toxicity testing, and benthic invertebrate community surveys).

The preponderance of the evidence indicated severe ecological impairment to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

E.3.1.3 Schoolhouse Brook

Five of the six measurement endpoints indicated the potential for ecological risk to the benthic invertebrate community in the reach of Schoolhouse Brook below the confluence with the main stem of Ely Brook. The three “chemical” LOEs (i.e., comparing sediment COPEC levels to benchmarks, comparing pore water COPEC levels to benchmarks, and assessing sediment divalent metal bioavailability based on AVS – SEM) and two of the three “biological” LOEs (i.e., bulk sediment toxicity testing and benthic invertebrate community surveys) resulted in conclusions of risk. The one exception was pore water acute toxicity testing, which did not show toxicity in the two test species after 96 hours of exposure.

The preponderance of the evidence indicated severe ecological impairment to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

E.3.1.4 The EBOR

Five of the six measurement endpoints showed a lack of ecological risk to the benthic invertebrate community in the reach of the EBOR below the confluence with Schoolhouse Brook. Two of the three “chemical” LOEs (i.e., comparing sediment COPEC levels to benchmarks and comparing pore water COPEC levels to benchmarks) and the three “biological” LOEs (i.e., pore water toxicity testing, bulk sediment toxicity testing, and benthic invertebrate community surveys) showed no risk. The one exception was assessing sediment AVS – SEM which indicated the potential for divalent metal bioavailability.

The preponderance of the evidence indicated no significant risk to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

E.3.2 Water column invertebrate community

The potential for ecological risk to the water column invertebrate community exposed to Site-related contamination was assessed only in the four ponds on the east branch of Ely Brook because they represented the only lentic habitat on or off the Site. One measurement endpoint was used, namely comparing dissolved COPEC concentrations in surface water samples to benchmarks. The results of a second measurement endpoint based on toxicity testing of surface water using the water flea were invalidated because the test did not meet minimum test acceptability criteria.

The one available LOE for this receptor group showed a low potential for ecological risk in ponds 2 and 3 (associated with small exceedances of dissolved Mn in both cases), but a high potential for ecological risk in pond 5 (associated mainly with high levels of dissolved Cu). No risk was found to water column invertebrates exposed to surface water in pond 4.

The preponderance of the evidence indicated the potential for low level of ecological risk in ponds 2 and 3, and high level of ecological risk in pond 5. The reliability of this conclusion is low because it is based on a single, semi-qualitative LOE.

E.3.3 Fish

The potential for ecological risk to fish populations exposed to Site-related contamination was assessed using up to four measurement endpoints (note: the ponds on the east branch of Ely Brook were excluded from this evaluation because they lacked fish):

- Compare dissolved COPEC concentrations in surface water samples to surface water benchmarks (main stem Ely brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in larval fathead minnows exposed for 10 days to surface water samples (main stem of Ely Brook and Schoolhouse Brook).
- Compare COPEC levels measured in whole fish to CBRs (Schoolhouse Brook and the EBOR).
- Evaluate the structure and function of the fish community in the field (Schoolhouse Brook and the EBOR).

E.3.3.1 The main stem of Ely Brook

A potential for severe ecological risk to fish was identified in the main stem of Ely Brook. This conclusion was supported by one “chemical” LOE (i.e., comparing surface water COPEC to benchmarks) and one “biological” LOE (i.e., surface water toxicity testing). A second “biological” LOE (i.e., evaluating the structure and function of the fish community) could not be used because fish were absent from the main stem of Ely Brook, even though it should be able to support fish. This observation gave indirect evidence of the severe impact of AMD on this habitat.

The preponderance of the evidence indicated severe ecological impairment to the fish community in the main stem of Ely Brook in response to AMD. The reliability of this conclusion is high because it is based on multiple lines of evidence, including quantitative biological field data.

E.3.3.2 Schoolhouse Brook

All four measurement endpoints indicated the potential for ecological risk to the fish community in the reach of Schoolhouse Brook below the confluence with the main stem of Ely Brook. The one “chemical” LOE (i.e., comparing surface water COPEC levels to benchmarks) and all three “biological” LOEs (i.e., surface water toxicity testing, fish tissue residue analysis, and fish community surveys) resulted in conclusions of risk. Comparing the fish tissue residues to CBRs provided the weakest evidence in support of risk, presumably because fish with higher tissue residues levels (particularly Cu) died off and would not be available for sampling.

The preponderance of the evidence indicated severe ecological impairment to the fish community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

E.3.3.3 The EBOR

Two of the three measurement endpoints showed a lack of ecological risk to the fish community in the reach of the EBOR below the confluence with Schoolhouse Brook. The one “chemical” LOE (i.e., comparing surface water COPEC levels to benchmarks) showed a low potential for ecological risk associated with exposures to dissolved silver and zinc (but not Cu). Both “biological” LOEs (i.e., surface water toxicity testing and fish community surveys) showed a lack of risk.

However, the fish surveys provided contradictory results. The fish sample collected from the EBOR just downstream of the confluence with Schoolhouse Brook and at one downgradient location showed a healthy community. However, fish samples collected at two more downstream locations showed degraded communities. More sampling at one of those two locations the following year showed a healthy community. This evidence was interpreted to mean that this apparent impairment was not systemic and may have been related to an unknown sampling bias.

The preponderance of the evidence indicated no significant risk to the fish community in this habitat in response to AMD. The reliability of this conclusion is moderate-low because the “chemical” LOE indicated a potential for ecological risk and the fish community surveys gave contradictory results.

E.3.4 AMPHIBIANS

The potential for ecological risk to amphibians exposed to Site-related contamination was assessed only for the four ponds on the east branch of Ely Brook using up to three measurement endpoints (depending on the pond), as follows:

- Compare dissolved COPEC concentrations in surface water samples to published surface water benchmarks (ponds 2 to 5).
- Measure survival and growth in fathead minnow larvae (surrogates for amphibian larval stages) exposed for 7 days to surface water samples (ponds 4 and 5 only).
- Evaluate hatching and survival of wood frog eggs and tadpoles exposed in the field (ponds 4 and 5 only).

Only the first measurement endpoint was assessed in all four ponds. This single “chemical” LOE showed a low potential for ecological risk in ponds 2 and 3 (associated with exceedances of dissolved Mn in both cases), but a high potential for ecological risk in pond 5 (associated mainly with high levels of dissolved Cu). No risk was found to larval amphibians exposed to surface water in pond 4.

The two remaining measurement endpoints were evaluated only in ponds 4 and 5. These two “biological” LOEs identified ecological risk. The surface waters from these two ponds were toxic to fish larvae tested in the laboratory and to tadpoles (but not frog eggs) exposed in the field. The results of the tadpole study were compromised due to unexpected and persistent mortality in the on- and off-Site reference locations. Only the mortality data generated after the first week of tadpole exposure in the field were used semi-qualitatively in the evaluation.

The preponderance of the evidence indicated the aquatic life stages of amphibians experienced low risk in ponds 2 and 3, but high risk in ponds 4 and 5. The reliability of this conclusion is medium because it is based on multiple lines of evidence, including laboratory and field exposures. However, the field exposures using tadpoles only provided partial results.

E.3.5 INSECTIVOROUS BIRDS

The potential for ecological risk to insectivorous birds feeding over the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat):

- Estimate the COPEC residues in winged aquatic insects and use food chain modeling to calculate daily doses to tree swallows for comparison to TRVs (Schoolhouse Brook and the EBOR).

E.3.5.1 Schoolhouse Brook

The available measurement endpoint identified the potential for ecological risk to insectivorous birds feeding over Schoolhouse Brook. Cu was the main risk driver in this habitat, although the risk exceedances were relatively small. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

E.3.5.2 The EBOR

The available measurement endpoint identified the potential for ecological risk to insectivorous birds feeding over the EBOR. Cu was the main risk driver in this habitat, although the risk exceedances were small and unlikely to cause severe long-term impairment to this receptor group. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

E.3.6 INSECTIVOROUS MAMMALS

The potential for ecological risk to insectivorous mammals feeding over the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat):

- Estimate the COPEC residues in winged aquatic insects and use food chain modeling to calculate daily doses to small-footed bats for comparison to TRVs (Schoolhouse Brook and the EBOR).

E.3.6.1 Schoolhouse Brook

The available measurement endpoint identified a strong potential for ecological risk to insectivorous mammals feeding over Schoolhouse Brook. Cu was the main risk driver in this habitat. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

E.3.6.2 The EBOR

The available measurement endpoint identified the potential for ecological risk to insectivorous mammals feeding over the EBOR. Cu was the main risk driver in this habitat, although the risk was relatively small. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

E.3.7 PISCIVOROUS BIRDS AND MAMMALS

The potential for ecological risk to piscivorous birds and mammals feeding in the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat and lacked fish):

- Measure the COPEC residues in fish and use food chain modeling to calculate daily doses to belted kingfishers and mink for comparison to avian and mammalian TRVs (Schoolhouse Brook and the EBOR).

E.3.7.1 <u>Schoolhouse Brook</u>

The available measurement endpoint did not identify the potential for ecological risk to piscivorous birds and mammals feeding over Schoolhouse Brook. The reliability of this conclusion is moderate because it is based on measured fish residue values but using simplistic food chain modeling assumptions.

E.3.7.2 <u>The EBOR</u>

The available measurement endpoint did not identify the potential for ecological risk to piscivorous birds and mammals feeding over the EBOR. The reliability of this conclusion is moderate because it is based on measured fish residue values but using simplistic food chain modeling assumptions.

LIST OF ACRONYMS

Ag	Silver
Al	Aluminum
ALU	Aquatic Life Use
AMD	Acid Mine Drainage
As	Arsenic
AUF	Area Use Factor
AVS	Acid Volatile Sulfides
Ba	Barium
BAF	Bioaccumulation Factor
BAV	Bioavailability Adjustment Factor
Be	Beryllium
BERA	Baseline Ecological Risk Assessment
BI	Biotic Index
BSAF	Biota-to-Sediment Accumulation Factor
BW	Body Weight
CBR	Critical Body Residue
Cd	Cadmium
CERC	Columbia Environmental Research Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CN	Cyanide
Co	Cobalt
COPEC	Contaminant of Potential Ecological Concern
Cr	Chromium
CTE	Central Tendency Exposure
Cu	Copper
CWIBI	Cold Water Index of Biologic Integrity
DF	Dietary Fraction
DL	Detection Limit
DQO	Data Quality Objective
DW	Dry Weight
EBOR	East Branch of the Ompompanoosuc River
EDD	Estimated Daily Dose
EF	Extrapolation Factor
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
EPT	Ephemeroptera, Plecoptera, and Tricoptera
EPTC	Ephemeroptera, Plecoptera, Tricoptera, Chironomida
ERAGs	Ecological Risk Assessment Guidelines
ER-L	Effects Range - Low
ER-M	Effects Range - Median
Eq-P	Equilibrium Partitioning
ET	Ecotox Threshold
EU	Exposure Unit
Fe	Iron
FIR	Food Ingestion Rate
FS	Feasibility Study
HQ	Hazard Quotient
Hg	Mercury
IBI	Index of Biotic Integrity

IR	Ingestion Rate
IR	Incremental Risk
LCV	Lowest Chronic Value
LEL	Lowest Effect Level
LMWPs	Lower Mine Waste Piles
LOAEL	Lowest Observed Adverse Effect Level
LOC	Level of Confidence
LOE	Line of Evidence
MAC	Maximum Allowable Concentrations
MeHg	Methylmercury
mg/kg	milligrams per kilogram (parts per million)
mg/kg/d	milligrams per kilogram per day
mg/kg BW/d	milligrams per kilogram body weight per day
mg/L	milligrams per liter (parts per million)
MHG	Medium High-Gradient
Mn	Manganese
Mo	Molybdenum
MWIBI	Mixed Water Index of Biotic Integrity
NA	Not Available
NCP	National Contingency Plan
NERL	New England Regional Laboratory
Ni	Nickel
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
NPL	National Priorities List
NRWQC	National Ambient Water Quality Criteria
ORNL	Oak Ridge National Laboratory
PE	Performance Evaluation
Pb	Lead
PEC	Probable Effects Concentration
PMA-O	Percent Model Affinity of Orders
ppb	parts per billion
PPCS-Func.	Pinkham-Pearson Coefficient of Similarity – Functional Groups
ppm	parts per million
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROC	Receptor of Concern
RPM	Remedial Project Manager
SAV	Secondary Acute Value
Sb	Antimony
SCM	Site Conceptual Model
SCV	Secondary Chronic Value
Se	Selenium
SEL	Severe Effect Level
SEM	Simultaneously Extracted Metal
SHG	Small High-Gradient
SIR	Sediment Ingestion Rate
SLERA	Screening-Level Ecological Risk Assessment
SMDP	Scientific Management Decision Point
TAC	Test Acceptability Criterion
TAL	Target Analyte List

TCL	Target Compound List
TDS	Total Dissolved Solids
T&E	Threatened and Endangered
TEC	Threshold Effect Concentration
Th	Thallium
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
TSS	Total Dissolved Solids
UCL	Upper Confidence Limit
UMWPs	Upper Mine Waste Piles
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Vanadium
VTDEC	Vermont Department of Environmental Conservation
VTNNHP	Vermont Nongame and Natural Heritage Program
WBOR	West Branch of the Ompompanoosuc River
WIR	Water Ingestion Rate
WOE	Weight of Evidence
WW	Wet Weight
Zn	Zinc

SECTION 1.0: GENERAL INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This report presents the aquatic portion of the Baseline Ecological Risk Assessment (BERA) for ecological receptors potentially exposed to mine-related wastes released by the Ely Copper Mine Superfund Site (the Site), in Vershire, VT. The BERA assesses the potential risk from exposure to contaminated surface water and sediment at the Site (i.e., the main stem of Ely Brook and Ponds 2 through 5 located on the east branch of Ely Brook) and down-gradient from the Site (Schoolhouse Brook and the East Branch of the Ompompanoosuc River [EBOR]).

The objectives of this BERA are to describe the likelihood, extent, and severity of ecological risk under existing conditions to aquatic receptors (e.g., invertebrates, fish, amphibians) living in the affected waterways, or bird and mammal wildlife receptors exposed via the food chain to mine-related contamination in the water ways. A separate BERA report will address risk to terrestrial receptors.

The BERA supports the Ely Mine Remedial Investigation/Feasibility Study (RI/FS) being conducted under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C 9601, et seq., and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CRF Part 300.

The Ely Mine RI report was developed concurrently and provided much of the Site information included in this report.

1.2 REGULATORY FRAMEWORK

The following guidance and reference documents were used to prepare the aquatic portion of the BERA for the Site:

- USEPA. 1997. Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. Environmental Response Team, Edison, NJ.
- USEPA. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F.
- USEPA. 2000. Guidance for the Data Quality Objective Process. EPA/600/R-96/055.
- USEPA. 2001. Planning for Ecological Risk Assessment: Developing Management Objectives. EPA/630/R-01/001A.
- USEPA. 2002. Principles for Managing Contaminated Sediment Risks at Hazardous waste Sites. OSWER Directive 9285.6-08.
- USEPA. 2005a Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. EPA/540/R-05/012.

1.3 REPORT ORGANIZATION

The major sections of the aquatic BERA report are organized as follows:

Section 2.0 Site History and Description

This section describes the historical activities at the Site and the physical and ecological setting.

Section 3.0 Database development and data processing

This section describes: (a) the analytical chemistry data sets collected at the Site, (b) issues with analytical data quality; (c) the data sets used in the BERA, and (d) the data summary methods.

Section 4.0 Baseline Problem Formulation

This section: (a) selects the final Contaminants of Potential Ecological Concern (COPECs) at the ponds and the three streams at and downstream from the Site, (b) describes the Site Conceptual Model (SCM), (c) identifies the Exposure Units (EUs) used in the BERA, (d) identifies the Receptors of Concern (ROCs) for the different trophic levels, (e) selects the assessment endpoints and measures of effect, and (f) outlines the Weight of Evidence (WOE) approach.

Section 5.0 Characterization of Exposure

This section describes: (a) surface water, pore water, and sediment sampling results used to calculate central tendency and reasonable maximum Exposure Point Concentrations (EPCs); (b) the sampling effort to obtain fish for tissue residue analysis; and (c) the dietary exposure models specific to the target wildlife receptors.

Section 6.0 Characterization of Effects

This section summarizes: (a) the surface water and sediment benchmarks; (b) the results of field and laboratory toxicity tests using water column invertebrates, benthic invertebrates, wood frog eggs and tadpoles, and larval fish; (c) the field studies to assess the health of the benthic invertebrate and fish communities; (d) the fish Critical Body Residues (CBRs) to compare against tissue COPECs measured in field-collected fish; and (e) the bird and mammal Toxicity Reference Values (TRVs) to quantify risk from the dietary exposures calculated using the food chain models.

Section 7.0 Risk Characterization

This section combines the measures of exposure and toxicity to determine the likelihood of adverse effects to the target receptor groups. The Hazard Quotient (HQ) is used to identify the COPECs most responsible for risk. Residual risk, if appropriate, is also calculated by comparing site risk against the risk at local reference areas. The significance of the toxicity test responses are evaluated using statistical analysis. The results from the benthic invertebrate and fish community studies are compared to Site reference data and published indices. The WOE for each measurement endpoint is included in the evaluation to weigh the various lines of evidence. The section concludes with an uncertainty analysis.

Section 8.0 Summary and Conclusions

This section provides a summary and conclusion regarding the presence and extent of ecological risk at the various aquatic habitats potentially affected by acid mine drainage..

Section 9.0 References

This section provides all of the references used in the BERA report.

SECTION 2.0: SITE HISTORY AND DESCRIPTION

2.1 SITE DEFINITION

The Site is an abandoned Copper (Cu) mine located on Beanville Road in the Village of Vershire, Orange County, Vermont (Figure 2.1). The property covers about 1,800 acres, 275-350 acres of which were used for Cu mining activities from 1821 to 1920, with peak production in the 1870s and 1880s. Mining operations stopped in 1905, but resumed during World War I when a flotation mill was constructed onsite to process material from ore dumps. Additional activity consisted of removing "dump-ore" from the property between 1949 and 1950. The Site is currently owned by Ely Mine Forest Inc. and Green Crow Corporation. Portions of it are managed for commercial timberland.

2.2 SITE HISTORY

The Site extends up the Ely Brook watershed to the crest of a ridge. Several adits and inclined shafts accessed the ore body in a northeasterly direction near the top of the ridge. The topography consists of north-south trending hills and valleys. Piles of waste rock, smelter waste, and tailings generated from mining processes are scattered on the property. The smelter waste pile covers about 4.3 acres. It is located along the banks of Schoolhouse Brook at the southern section of the property. This pile consists of slag that exhibits a metallic luster. The tailings pile is located in the central section of the property and covers about 10.8 acres. This pile consists of a fine-grained material, reddish-brown in color at the surface. Several large waste rock piles are located in the upper section of the property closest to the old mine shafts and adits. All of these materials are rich in metals and sulfides. Sulfuric acid is produced and metals are dissolved and mobilized as water passes over and through these piles. This chemical activity results in low pH, metal-enriched Acid Mine Drainage (AMD) which enters local waterways.

Remnants of stone works from past mining operations are found throughout the property, consisting mostly of retaining walls. Vegetation is sparse in the vicinity of the waste rock pile, tailings pile, and the smelter waste pile. Woodlands cover the rest of the property. Downed trees and recent beaver dams are present in the small ponds located on the upper reach of the East Branch of Ely Brook. The Site has no restrictive barriers to pedestrian access. Local people use the property for recreation, including target practicing, hiking, and four-wheeling. A gun club has permission to access the property for hunting.

Past mining operations at the Site included cobbing, roasting, and smelting. The local ore, which averaged 3.3% Cu, was fragmented, or cobbed, to a product containing about 7.0% Cu. This material was smelted to produce a Cu matte, which consisted of a molten mixture of Cu/iron sulfide. A flotation mill was built in 1918 to extract more Cu from existing waste piles on the property. The extraction operation generated 19,000 tons of waste material in ten months, with a Cu level averaging 1.34%. The Bureau of Mines estimated that mining and smelting generated about 100,000 tons of tailings and slag at the Site.

The Site has been investigated by State and Federal agencies, and private contractors over the past 20 years. Numerous samples of mine tailings, slag, surface water, pore water, soil, sediment, ground water, and fish have been collected and analyzed for inorganics. The results show high levels of metals relative to nearby reference concentrations. The Vermont Department of Environmental Conservation (VT DEC) collected water samples and inventoried fish species in Schoolhouse Brook in 1988. Only blacknose dace (*Rhinichthys atralutus*) were present downstream of the confluence with Ely Brook. However, blacknose dace, longnose dace (*R. cataractae*), slimy sculpin (*Cottus cognatus*), brook trout (*Salvelinus fontinalis*), and rainbow trout (*Oncorhynchus mykiss*) were collected from a non-impaired stretch of Schoolhouse Brook upstream of the confluence with Ely Brook.

The VT DEC also concluded in 1991 that Cu affected the macroinvertebrate community of Schoolhouse Brook, downstream of the confluence with Ely Brook. A second macroinvertebrate survey on Schoolhouse Brook was conducted by the Bureau of Mines in 1995 to determine the impact of Site discharge. The study concluded that mine drainage had "slightly" impacted the water quality of Schoolhouse Brook as noted by physical and biological factors. More studies in support of this Baseline Ecological Risk Assessment (BERA) were performed between 2003 and 2007 on Ely Brook, Schoolhouse Brook, and the EBOR. These studies consisted of additional sampling (surface water, sediment, and pore water), habitat quality surveys, community surveys (benthic invertebrates and fish), tissue residue analysis (fish), and laboratory and field toxicity testing (invertebrates, fish, and amphibians).

The Bureau of Mines built an experimental biological treatment system at the Ely Copper Mine in 1995. A portion of Ely Brook was diverted into five 32-gallon barrels in series for treatment with manure, compost, wood chips, and limestone. These materials served as a bacterial sulfate-reduction system to precipitate metals. Water samples were collected monthly from the system and Ely Brook. The treatment removed metals and sulfate, increased alkalinity, and decreased the acidity of the water. However, the data were inconsistent due to a lack of regular monitoring and system maintenance.

Note that the remedial investigation report prepared for the former Ely Copper Mine provides more details on the physical setting and the history of this Site.

SECTION 3.0: DATABASE DEVELOPMENT AND DATA PROCESSING

3.1 DATA SOURCES

Table 3.1 summarizes the analytical data sets which were used in the aquatic portion of the BERA to calculate Exposure Point Concentrations (EPCs).

Table 3.1: Summary of analytical chemistry data sets used in the aquatic portion of the BERA

Sampling Dates	Sampling Organization	Major Analytes
Sediment		
8/25/1998	USGS	Metals, AVS/SEM
7/19/2000	ADL	Metals, AVS/SEM
10/2/2000	ADL	Metals, AVS/SEM
9/5/2001	ADL	Metals
9/10/2001	ADL	Metals
11/1/2004 – 11/4/2004	URS	Metals, AVS/SEM
6/20/2006 – 6/21/2006	USGS	Metals
8/22/2006 – 8/23/2006	USGS	Metals, AVS/SEM
9/19/2006	USGS	Metals
Surface Water		
5/8/2000	ADL	Metals (filtered and unfiltered)
7/6/2000	ADL	Metals (filtered and unfiltered)
7/19/2000	ADL	Metals (filtered and unfiltered)
9/20/2000	ADL	Metals (filtered and unfiltered)
5/1/2001 – 5/3/2001	ADL	Metals (filtered and unfiltered)
9/5/2001	ADL	Metals (filtered and unfiltered)
9/10/2001	ADL	Metals (filtered and unfiltered)
4/10/2002 – 4/11/2002	CRREL	Metals (filtered and unfiltered)
5/21/2002	CRREL	Metals (filtered and unfiltered)
6/20/2002	CRREL	Metals (filtered and unfiltered)
7/24/2002	CRREL	Metals (filtered and unfiltered)
8/20/2002	CRREL	Metals (filtered and unfiltered)
9/19/2002	CRREL	Metals (filtered and unfiltered)
11/1/2004 – 11/4/2004	URS	Metals (filtered and unfiltered), pH
10/5/2005	EPA	Metals (filtered and unfiltered)
5/2/2006 – 6/23/2006	EPA	Metals (filtered and unfiltered), pH

Table 3.1: Summary of analytical chemistry data sets used in the aquatic portion of the BERA		
Sampling Dates	**Sampling Organization**	**Major Analytes**
6/19/2006	EPA	Metals (filtered and unfiltered), pH
8/21/2006 – 8/23/2006	USGS	Metals (filtered and unfiltered), pH
9/19/2006	USGS	Metals (filtered and unfiltered), pH
4/9/2007	EPA	Metals (filtered and unfiltered)
4/11/2007	EPA	Metals (filtered and unfiltered)
5/2/2007 – 5/3/2007	URS	Metals (filtered and unfiltered), pH
Pore Water		
8/21/2006 – 8/23/2006	USGS	Metals (filtered and unfiltered)
9/19/2006 – 9/20/2006	USGS	Metals (filtered)
Fish Tissue		
9/12/2006 - 9/13/2006	USGS	Metals (whole fish)

ADL = Arthur D Little Consultants; AVS = acid volatile sulfides; CRREL = Cold Regions Research and Engineering laboratory; EPA = Environmental Protection Agency; SEM = simultaneously extracted metals; URS = URS Corp.; USGS = United States Geological Survey.

The analytical data were extracted from a master Access database prepared by the U.S. Geological Survey in 2007. The final data sets used in the BERA are provided in **Appendix 1** (sediment), **Appendix 2** (pore water), **Appendix 3** (surface water), and **Appendix 4** (fish tissue).

3.2 DATA QUALITY

The ultimate outcome of the data evaluation and summarization process is a database of the highest quality. The data sets used in this BERA were developed by compiling analytical data collected from the various ponds and streams at and down-gradient from the Site.

Analytical data were compiled and sorted by environmental matrix. Bulk sediment, sediment pore water, and surface water from the ponds and the three streams, together with fish collected from Schoolhouse Brook and the EBOR, were retained as target media for evaluation in the BERA.

This subsection summarizes the following topics:

- The surface water and pore water collection methods, number of samples collected, and the difference between total (unfiltered) versus dissolved (filtered) metals.
- The bulk sediment collection methods, number of samples collected, and Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM) measurements.
- The fish collection methods, number of samples collected, and whole fish tissue residue analyses.

3.2.1 <u>Evaluation of qualified and coded data</u>

All results assigned qualifiers indicating that the analyte was positively detected or presumptively present (e.g., data qualified as J or EB) were retained as detected results in the analytical database and used as reported. All results assigned qualifiers indicating that the analyte was not positively detected (i.e., U, UJ) were retained only as non-detected results in the analytical database. Finally, any result considered of inadequate quality for use in risk assessment (i.e., data qualified as R) was omitted from the risk calculations.

3.3 <u>COMPILING DATA SETS FOR USE IN THE AQUATIC PORTION OF THE BERA</u>

The final product of the data evaluation and summarization process is a comprehensive database for use in quantitative ERA. Individual data sets were developed by compiling analytical results for each matrix of interest (sediment, pore water, surface water, and fish tissue), analyte group (i.e., dissolved metals [normalized for hardness, when applicable] and total metals) and target locations (i.e., the ponds on the east branch of Ely Brook, the main stem of Ely brook, Schoolhouse Brook, the EBOR, and the reference locations).

Two decisions were made about including particular data in the evaluation. The first decision pertained to three sampling locations (EBT2-430M, EBT2-383M, EBT-315M) which were originally identified in the database as “Ely Brook”. Available maps showed that these samples were in fact collected at the outlets of pond 1 (EBT2-430M), pond 2 (EBT2-383M), and pond 4 (EBT-315M) located on the east branch of Ely Brook. The surface water and sediment data from these locations were included in the ponds 1, 2, and 4 data sets.

The second decision pertained to surface water data collected in 2002 by the CRREL ISCO samplers (one sampler each at Ely brook, Schoolhouse brook, and the EBOR). These data were not included because they consisted of a series of samples collected over 24 hours instead of one discrete sample at each sampling location. It would have required averaging the samples taken over 24 hours in order to develop a single value.

3.3.1 <u>Hardness-dependent metals</u>

The toxicities of cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), silver (Ag), and zinc (Zn) vary with surface water hardness (EPA, 2006). All else being equal, toxicity drops in hard water but increases in soft water at a metal-specific but non-linear rate. Hard water has more calcium to compete with these metals for binding sites on gill tissue. Calcium binding protects the tight junctions between gill cells, thereby avoiding loss of blood electrolytes or increased inflow of water. Those junctions become less tight when they are occupied by metals, which can result in excessive electrolyte loss in fish, and ultimately death.

The surface water samples used in the BERA were collected over several years between March and November. Surface water hardness varies seasonally in the ponds and the three streams, with the lowest hardness observed during spring snowmelt and the highest hardness occurring in summer. Conversely, metal concentrations in surface water are highest in early spring and lowest during base flow in late summer.

It would be inaccurate to calculate exposure concentrations for aquatic invertebrates, fish, and amphibians without accounting for the differences in surface water hardness between sampling locations and sampling times. The reason is that 20 µg/L Cu at 25 mg/L hardness could be quite toxic, whereas the same Cu level at 175 mg/L hardness would not be toxic. This issue is not relevant to wildlife receptors that ingest water from the streams because their total uptake of metals via drinking is independent of hardness.

Appendix 5 describes the approach to normalize Cd, Cr, Cu, Pb, Ni, Ag, and Zn concentrations to a standard hardness of 100 mg/L for quantifying exposures to aquatic receptors. *Any hardness value can be used for this purpose without affecting the outcome*. However, 100 mg/L was used as the standard value because it represents the concentration selected by USEPA (2006) to calculate the National Recommended Water Quality Criteria (NRWQC).

3.3.2 Data summarization method

Each data set was summarized to provide the following descriptors:

- frequency of detection (= number of detected values over the number of samples analyzed),
- minimum detected value (with data qualifier),
- maximum detected value (with data qualifier), and
- sampling location of the maximum detected value.

The analytical data for total metals (unfiltered and not normalized for hardness) and dissolved metals (filtered and normalized for hardness) was summarized separately.

The following procedures were used to calculate the summary statistics used in the BERA:

- Results assigned qualifiers indicating that an analyte was positively detected or presumptively present were retained for use as reported in the risk calculations.
- Results assigned qualifiers indicating that an analyte was not positively detected were retained at one half of their Detection Limit (DL) for use in the exposure calculations.
- Data qualified as rejected were not used in the risk calculations.
- Data for samples collected from the same location but at different times were treated as separate samples.
- Data from duplicate samples (i.e., samples collected at the same location and the same time) had not been incorporated into the database at the time of this BERA evaluation.
- Pro UCL (version 4.00.02) was used to test datasets for outliers. All potential outliers were included in this evaluation.

SECTION 4.0: BASELINE PROBLEM FORMULATION

4.1 SCOPE OF THE BASELINE PROBLEM FORMULATION

The baseline problem formulation establishes the goals, breadth, and focus of the BERA. It also defines the assessment endpoints, or specific ecological values to be protected (EPA, 1997). This process consists of the following activities:

- Refining the list of COPECs at the Site based on the outcome of the Screening-Level Ecological Risk Assessment (SLERA);
- Characterizing the potential ecological effects of the COPECs on aquatic resources;
- Reviewing and refining the information on the fate and transport of the COPECs
- Developing a detailed SCM;
- Developing management goals and objectives to provide an explicit statement of the desired condition of the valued ecosystem being protected;
- Identifying assessment endpoints with their associated risk questions; and
- Identifying measurement endpoints to help quantify the potential for ecological risk to the assessment endpoints.

4.2 RESULTS OF THE SLERA

A simplified SLERA was completed in 2007 as Steps 1 and 2 in the Ecological Risk Assessment Guidance (ERAG) process (see **Appendix 6**). This SLERA used all available surface water and sediment analytical data collected from various waterways affected by the Site to identify potential aquatic COPECs. The simplified SLERA divided the analytical data into four EUs, as follows:

- Ponds 2 to 5 combined (excluding pond 1, the upstream reference location) in the upper reaches of the East Branch of Ely Brook;
- The main stem of Ely Brook (about 0.6 miles long), between where the AMD-impacted small tributaries enter Ely Brook and the confluence with Schoolhouse Brook;
- Schoolhouse Brook (about 2.2 miles long), between where the main stem of Ely Brook enters Schoolhouse brook and the confluence with the EBOR; and
- The EBOR (around 8 to 10 miles long), downstream of the confluence with Schoolhouse Brook.

The maximum measured concentrations of metals in each EU were used as the conservative exposure concentrations, whereas screening-level surface water and sediment benchmarks were used as a measure of toxicity. The maximum concentrations of the six hardness-dependent metals (i.e., Cd, Cu, Pb, Ni, Ag, and Zn) were first normalized to 100 mg/L hardness (see **Appendix 5** for details on the procedure) before they were compared to the EPA's standard NRWQCs, which apply to surface water containing 100 mg/L hardness.

HQs were calculated by dividing the maximum metal concentrations from each EU into their respective screening benchmarks. A metal was retained as a COPEC if the HQ exceeded 1.0., no screening benchmark was available, or the maximum detection limit of a non-detected analyte exceeded its benchmark.

The SLERA showed that many metals in surface water and sediment exceeded their conservative screening benchmarks in the four aquatic EUs. These exceedances present a potential for adverse effects to aquatic receptors residing in those aquatic habitats or use them for reproduction. It was recommended that the ERA should continue to a BERA to better quantify this potential for ecological risk.

4.3 NATURE AND EXTENT OF CONTAMINATION IN AQUATIC HABITATS

The SLERA identified many mining-related metals in surface water and sediment which exceeded conservative benchmarks. The metals with the highest screening-level HQs are summarized in **Exhibit 4.1** for each EU and matrix (see **Appendix 5** for additional details).

Exhibit 4.1: Major COPECs identified by the SLERA

Exposure Area	Surface water	Sediment
The ponds	Cu (HQ = 74), Cd (HQ = 7.3), and Zn (HQ = 3.1); and	Ba (HQ = 539), Cu (HQ = 112), and Zn (HQ = 4.2)
Main stem Ely Brook	Cu (HQ = 736), Al (HQ = 391), and Cd (HQ = 34.9)	Ba (HQ = 337), Cu (HQ = 209), and Se (HQ = 152)
Schoolhouse Brook	Cu (HQ = 22.5); Cd (HQ = 3.3), and Al (HQ = 2.1)	Ba (HQ = 284), Cu (HQ = 44), and Se (HQ = 33.8)
East branch of the Ompompanoosuc River	Zn (HQ = 75.8), Cu (HQ = 8.5), and Ba (HQ = 1.7)	Ba (HQ = 279), Cu (HQ = 8.2), and Se (HQ = 2.8)

Figure 4.1 shows the major tributaries of Ely Brook and the major mining-related features described in this subsection. **Figure 4.2** highlights the five ponds located in the upper reach of the east branch of Ely Brook. **Figure 4.3** shows the relationship between Ely Brook and the two down-gradient waterways (i.e., Schoolhouse Brook and the EBOR).

- *Ely Brook*

Ely Brook is a small high-gradient cold-water stream (maximum width between five and seven ft). The brook, which represents the major drainage feature at the Site, flows in a general north to south direction between its source located in the hills west of the Site to its confluence with Schoolhouse Brook. Ely Brook has a total drainage area of 0.43 mi^2, a length of about 0.9 mile, and a range in altitude from about 977 ft to 1264 ft. The surficial geology of the basin is predominantly till. A qualitative geomorphic characterization of the brook found about 45% riffles, 42% runs, and 13% pools. Several tributaries flow into Ely Brook from the east (the “Site” side), as follows.

The <u>west branch</u> represents the upper half of Ely Brook. Only the upper reach of the west branch has not been affected by AMD. Its substrate consists of pebbles and boulders. An intermittent tributary which originates at a small mine waste pile by Shaft No. 4, located 200 ft west of the Upper Mine Waste Piles (UMWPs) provides mine-derived contamination (see **Figure 4.1**). This intermittent tributary enters the west branch about 500 ft upstream from its confluence with the east branch (see below).

The <u>east branch</u> of Ely Brook originates in a poorly-drained, swampy valley on the eastern side of the Site (see **Figures 4.1** and **4.2**). This valley supports five small ponds, some of which are maintained by beavers. Pond 1, the most upstream of the ponds, is by far the largest body of water (about 0.94 acres) and forms the source for the east branch. The four remaining ponds are located downstream of each other and are all hydraulically connected.

Pond 1 originates behind an earth and rubble dam constructed in the late 19th century. It served as a water-supply reservoir to provide a continuous source of water to the nearby mining facilities. Historical information suggests that Pond 1 is spring-fed. A small seep of AMD enters Pond 4. A waste rock pile is located adjacent to Pond 5 (see **Figure 4.2**).

The east branch exits Pond 5 and flows due south, parallel to the Site access road, for about 400 ft before making a sharp turn to the west. It then cuts through the Lower Mine Waste Piles (LMWPs) before merging with the west branch of Ely Brook. The east branch varies in maximum width between one and four ft, depending on location, flow, and season. The substrate in this tributary after it leaves the swampy valley consists almost entirely of mine-derived waste. The surface water of this tributary upon exiting Pond 5 is acidified and enriched with metals.

The <u>north branch</u> of Ely Brook starts as a network of small drainage channels which have their source at the UMWPs (see **Figure 4.1**). The water in this branch originates from several permanent seeps at the base of the UMWPs. The volume of water flowing through the north branch fluctuates, but surges during spring snowmelt or periods of high rainfall as a result of increased surface run-off. The maximum width varies between less than one ft and three ft, depending on location, flow, and season. The north branch flows along the western edge of the LMWPs before merging with the east branch. The substrate in this tributary consists entirely of mine-derived waste. The surface water in the north branch is acidified and enriched with metals.

The <u>main stem</u> represents the lower half of Ely Brook. A small, intermittent tributary flows between the former ore roast beds and this section of Ely Brook. The main stem flows between where the west and east branches converge and the confluence with Schoolhouse Brook (see **Figure 4.1**). The surface water of the main stem is highly acidic (pH < 4.0) due to AMD input from the east, west, and north branches, plus the former roast bed tributary. It also contains dissolved Cu levels between two to three orders of magnitude above EPA's acute and chronic surface water guidelines for the protection of aquatic life. The main stem shows all of the signs of an AMD-impacted stream: it is biologically devoid, the substrate consists entirely of mine-derived waste and has a pronounced orange-red color due to excessive metal precipitation.

More details on the physical setting of Ely Brook are available from Seal et al. (2010).

- *Schoolhouse Brook*

Schoolhouse Brook is a small, high-gradient stream with a total drainage area of 9.7 mi^2, a length of about 4.5 miles, and a range in altitude from about 693 ft to 1584 ft. This brook flows in a general west to east direction along the southern border of the Site (see **Figure 4.1**). Two tributaries flow into Schoolhouse Brook below the confluence with Ely Brook. The contributing drainage area for these tributaries is 2.7 mi^2.

The surficial geology of the basin is predominantly till. A qualitative geomorphic characterization of the stream segment between Ely Brook and the EBOR found about 95% riffles, 3% runs, and 2% pools. The substrate consists mostly of coarse sand, gravel, cobbles, and boulders. The average slope for this stream segment is 2.6 percent. However, a few short sections of Schoolhouse Brook flatten out, slow down, and become more depositional near the confluence with the EBOR.

The main stem of Ely Brook joins Schoolhouse Brook about 100 ft upstream from the smelter slag piles. Schoolhouse Brook then flows next to the slag piles, which likely represent an independent source of COPECs, for about 300 ft. It joins the EBOR about two miles downstream from the Site. More details on the physical setting of Schoolhouse Brook are available from Seal et al. (2010).

Past investigations indicated that high AMD has affected the benthic invertebrate and fish communities in Schoolhouse Brook downstream from the confluence with Ely Brook. Surface water analyses showed that Cu exceeded its chronic surface water benchmark further downstream.

- *East Branch of the Ompompanoosuc River*

The EBOR joins the west branch of the Ompompanoosuc River (WBOR) at Union Village to form the Ompompanoosuc River, which flows into the Connecticut River. The EBOR above the confluence with the WBOR has a total drainage area of 64.8 mi^2 and is characterized as a medium high-gradient stream. The surficial geology of the EBOR basin is predominantly till. However, the surficial geology underlying the stream channel in the study area is characterized as delta gravel, lake sand, and pebbly sand.

A qualitative geomorphic characterization of a stream segment of the EBOR below the confluence with Schoolhouse Brook found about 39% riffles, 51% runs, and 10% pools. The average slope for this stream segment is 0.5 percent. The substrate consists mostly of sand, gravel, cobbles, and boulders. More details on the physical setting of Schoolhouse Brook are available from Seal et al. (2010).

Even though the EBOR flows well downstream from the site (see **Figure 4.3**), it may still experience minor impacts from past or current releases of AMD via Ely Brook and Schoolhouse Brook, particularly during the snowmelt in early spring.

4.4 <u>REFINEMENT AND SELECTION OF THE FINAL COPECS</u>

4.4.1 <u>Introduction</u>

The COPECs identified in the SLERA were re-evaluated and then refined as the first task in the Baseline Problem Formulation. No additional data were collected and no changes were made to the screening benchmarks since the submission of the SLERA. Hence, the re-evaluation did not proceed on those bases. Instead, the COPECs were refined using EPA guidance (USEPA, 2001a), which states that one objective of the Baseline Problem Formulation is to refine the COPECs to better focus the BERA. The following components were considered in the refinement process:

1) *Supplemental Component 1: Reference levels*. USEPA guidance cautions that comparison to local reference levels generally cannot be used at this stage to eliminate COPECs owing to the need to fully assess site risks (EPA, 1997). The accepted approach in EPA Region 1 is to consider reference concentrations only in the risk characterization part of the BERA by calculating incremental risk, if necessary. A comparison to reference levels was not conducted at the COPEC refinement stage based on this requirement and on discussions with the Remedial Project Manager (RPM).

2) *Supplemental Component 2*: *Frequency and Magnitude of Detection.* ERA guidance allows COPECs to be eliminated based on frequency of detection, given adequate data and after consultation with the RPM. The databases used in the SLERA were extensive and represented sampling performed in the spring, summer, and fall over several years at various locations within each EU. Based on the prevailing approach in EPA Region 1, and after consultation with the

RPM, it was decided that a COPEC would be eliminated at this stage if it was detected in less than 5% of the samples collected from an EU, assuming that at least 20 samples were available from that EU.

3) *Supplemental Component 3*: *Dietary Considerations*. The USEPA considers calcium, iron, magnesium, sodium, and potassium as essential physiological electrolytes (USEPA, 2001). These compounds are not believed to pose ecological risk when present at concentrations that allow them to function as nutrients. Alternatively, the USEPA also states that other inorganics such as selenium, copper, molybdenum, and boron can quickly transition from essential nutrients to toxicants at only slightly higher concentrations and can therefore not be eliminated. The essential physiological electrolytes, except for iron, were removed for this screening, because they were considered to be at concentrations that posed no potential for ecological risk. Iron was retained as a COPEC because of its high levels at some locations in the waterways affected by the Site.

The final sediment, pore water, and surface water COPEC were selected by EU as follows:

- A chemical was retained as COPEC if: (1) its maximum detected concentration exceeded its screening benchmark, (2) a screening benchmark was not available, or (3) the maximum detection limit of a non-detected analyte exceeded its benchmark when less than 20 samples were collected for analysis.

- A chemical was removed as a COPEC if: (1) its maximum detected concentration fell below its screening benchmark, (2) it was detected in less than 5% of the samples if at least 20 samples were collected for analysis, or (3) the maximum detection limit of a non-detected analyte did not exceed its benchmark.

The tissue COPECs for fish sampled in Schoolhouse Brook and the EBOR were selected as follows:

- A chemical was retained as a fish tissue COPEC if: (1) it was present above its detection limit in at least one fish sample, (2) it was not present above its detection limit in any fish samples, but the maximum detection limit exceeded the no effect fish CBR, or (3) it was not present above its detection limit in any fish samples, but a no effect fish CBR was not available.

- A chemical was removed as a fish tissue COPEC if it was not present above its detection limit in all fish samples and the maximum detection limit was less than the no effect CBR.

The surface water COPECs for use in wildlife food chain modeling (i.e., to estimate COPEC levels in drinking water) were selected as follows:

- A chemical was retained as a surface water COPEC for food chain modeling if it was detected in at least one surface water sample collected from an EU.

- A chemical was removed as a surface water COPEC for food chain modeling if: (1) it was not detected in any of the surface water samples from an EU, or (2) it was detected in less than 5% of the samples if at least 20 samples were collected for analysis.

The sediment COPECs for use in wildlife food chain modeling (i.e., to estimate COPEC levels in aquatic insects) were selected as follows:

- A chemical was retained as a sediment COPEC for food chain modeling if it was detected in at least one sediment sample collected from an EU.

- A chemical was removed as a sediment COPEC if: (1) it was not detected in any of the sediment samples from an EU, or (2) it was detected in less than 5% of the samples if at least 20 samples were collected for analysis.

4.4.2 Sediment COPECs for benthic invertebrates

The final sediment COPECs for benthic invertebrates are shown in **Attachments 4.1 to 4.4** (the four ponds on the east branch of Ely Brook), **Attachment 4.5** (main stem Ely Brook), **Attachment 4.6** (Schoolhouse Brook), and **Attachment 4.7** (the EBOR). **Attachment 4.8** summarizes the final sediment COPECs at the EUs evaluated in this BERA.

4.4.3 Pore water COPECs for benthic invertebrates

The final pore water COPECs for benthic invertebrates are shown in **Attachment 4.9** (main stem Ely Brook), **Attachment 4.10** (Schoolhouse Brook), and **Attachment 4.11** (the EBOR). **Attachment 4.12** summarizes the final pore water COPECs at the EUs evaluated in this BERA.

4.4.4 Surface water COPECs for aquatic receptors

The surface water COPECs for aquatic receptors (i.e., water column invertebrates, fish, and amphibian embryo-larvae) were identified using the dissolved metals data, which represent the bioavailable fraction responsible for toxicity (EPA, 2006). The final surface water COPECs for aquatic receptors are shown in **Attachments 4.13 to 4.16** (the four ponds on the east branch of Ely Brook), **Attachment 4.17** (main stem Ely Brook), **Attachment 4.18** (Schoolhouse Brook), and **Attachment 4.19** (the EBOR). **Attachment 4.20** summarizes the final surface water COPECs for aquatic receptors at the EUs evaluated in this BERA.

4.4.5 Fish tissue COPECs

The fish tissue COPECs to compare against fish CBRs were identified separately for brook trout and blacknose dace in Schoolhouse Brook (**Attachments 4.21 and 4.22**) and in the EBOR (**Attachment 4.23 and 4.24**). **Attachment 4.25** summarizes the final fish tissue COPECs to compare against fish CBRs at the EUs evaluated in this BERA.

A second set of fish tissue COPECs for use in wildlife food chain modeling was created by combining the brook trout and blacknose dace tissue date from Schoolhouse Brook (**Attachment 4.26**) and the EBOR (**Attachment 4.27**). Combining the two data sets was needed for food chain modeling due to the minimal number of trout samples collected from Schoolhouse Brook (n = 1) and the EBOR (n = 2). **Attachment 4.28** summarizes the final fish tissue COPECs for use on food chain modeling at the EUs evaluated in this BERA.

4.4.6 Surface water COPECs for use in wildlife food chain modeling

Wildlife receptors foraging along the waterways are exposed to total metals (with no hardness adjustment) when ingesting surface water. The final surface water COPECs for wildlife receptors are shown in **Attachment 4.29** (Schoolhouse Brook) and **Attachment 4.30** (EBOR). **Attachment 4.31** summarizes the final surface water COPECs for wildlife receptors foraging at the EUs evaluated in this BERA (note: the ponds on the east branch of Ely Brook were not included because they were considered too small to provide viable habitat for birds and mammals feeding on aquatic organisms; the main stem of Ely Brook was also excluded because this habitat is largely devoid of aquatic insects and fish under current conditions).

4.4.7 Sediment COPECs for use in wildlife food chain modeling

Three of the four wildlife receptors evaluated in this BERA were assumed to feed on aquatic or emergent insects. However, no insects were collected for chemical analyses to generate tissue residue data for use in food chain modeling. Instead, COPEC concentrations in insects were estimated using generic sediment-to-biota accumulation factors (see Section 5.4.3 for more details). The COPECs used in those calculations were the same ones as the sediment COPECs identified in Section 4.4.1, specifically the sediment COPECs in Schoolhouse Brook (**Attachment 4.6**) and the EBOR (**Attachment 4.7**) where insectivores were assumed to forage.

4.5 AQUATIC COMMUNITIES

4.5.1 Aquatic habitat description

The aquatic habitats evaluated in this BERA were described in Section 3.3. The five small ponds on the east branch of Ely Mine are the only lake-like habitats at the Site, even though surface water flows from one pond into the other. The other affected waterways are the main stem of Ely Brook, Schoolhouse Brook, and the EBOR. These streams are all flowing habitats, characterized by sand, gravel and boulder substrate, except for Ely Brook which has substrate dominated by mine waste (i.e., finer-grained tailings material).

4.5.2 Aquatic animals

Past field observations indicated that Ponds 1, 2, 3, and 4 on the east branch of Ely Brook are used extensively for spring breeding by local populations of wood frogs (*Rana sylvatica*), green frogs (*Rana clamitans*), and red-spotted newts (*Notophthalmus viridescens*). No fish were observed in any of these ponds during multiple visits in the spring of 2007 and 2008.

The main stem of Ely Brook is devoid of fish due to the low pH and high metal content of its surface water. Benthic invertebrates are also essentially absent from this stretch.

Schoolhouse Brook below its confluence with Ely Brook supports degraded populations of cold-water fish species and benthic invertebrates all the way to the EBOR. The major fish species identified during past fisheries surveys in the impacted portion of this brook consisted of brook trout (*Salvelinus fontinalis*), blacknose dace (*Rhinichthys atralutus*), longnose dace (*Rhinichthys cataractae*), and slimy sculpin (*Cattus cognatus*).

The EBOR below the confluence with Ely Brook shows a similar fish species composition, except that brook trout are rare but Atlantic salmon (*Salmo salar*) are more common.

4.6 RISK MANAGEMENT GOALS AND OBJECTIVES

As defined by U.S. EPA (2001b), “a *risk management goal* is a general statement of the desired condition or direction of preference for the entity to be protected. It is often developed independently of the risk assessment process. […], *management objectives*, while similar to management goals, differ in that they should be specific enough to use when developing assessment endpoints and measures.”

The following risk management goal is proposed:

Maintain the quality of sediment, surface water, and food sources in order to support a "functioning ecosystem" for aquatic and terrestrial receptors inhabiting or using the waterways at or downstream from the Ely Copper Mine.

The management objectives that follow from this proposed management goal are as follows:

- Restore the quality of surface water and sediment in the waterways impacted by the historical operations of the Ely Copper Mine to the degree and quality that they can support viable and self-sustaining populations of benthic invertebrates, amphibians, and fish, and wildlife receptors that depend on them for food.

- Ensure that sources of contamination originating from historical operations of the Ely Copper Mine are controlled so that they are prevented from re-contaminating the aquatic habitats in the future.

4.7 SITE CONCEPTUAL MODEL

4.7.1 Contaminant fate and transport

The available information on the Site was reviewed to determine which fate and transport mechanisms might result in complete exposure pathways to aquatic receptors or to terrestrial receptors feeding on aquatic prey. The goal was to identify the major components of a complete exposure pathway, which consist of the following.

- Source of contamination,
- Release and transport mechanisms,
- Contact points and exposure media,
- Routes of entry, and
- Key receptors.

Each component is discussed below.

4.7.1.1 Sources of contamination

The following mine-related features are potential sources of contamination to the aquatic environments at and downstream from Ely Mine. These sources are listed from up-gradient (north) to down-gradient (south) (see also **Figure 4.1**).

Primary sources

(a) The Upper Mine Waste Piles (UMWPs)

Six individual waste rock piles are located against a ridge at the upper end of the Site, closest to the old mine shafts and adits. These piles, which are known collectively as the UMWPs, are essentially devoid of vegetation. Waste rock and low-grade ore was deposited in piles as the ore was removed from the underground mine which ran along the nearby ridge line. The materials making up the UMWPs range from fine-grained soil to boulder-sized waste rocks. The USGS reported Cu concentrations ranging between 2,050 and 5,660 mg/kg in composited surface soil samples collected from the six waste piles at this location (USGS, 2004). These piles represent a significant source of AMD.

(b) The artesian well

An artesian well is located just up-gradient from the Lower Mine Waste Piles (LMWPs). Groundwater wells up from this location year-round. Minerals and metals have been deposited around this well, creating a terrace-like appearance. The surface of this terrace is darkly stained.

Water from the artesian well flows into the north branch of Ely Brook.

(c) The Lower Mine Waste Piles

The LMWPs are located below the artesian well. The piles are traversed by the main access road which runs in a south-to-north direction. The east branch of Ely Brook transects this area from east to west and joins with the north branch just before its confluence with the main stem of Ely Brook. The LMWPs cover about 15 acres and consist of fine, orange-reddish soil devoid of vegetation. The piles have a flattened appearance and have been severely eroded by past surface runoff. The USGS reported Cu concentrations between 5,100 and 7,020 mg/kg in three composited surface soil samples collected from the LMWPs (USGS, 2004).

(d) The slag piles

The slag piles are located along the east bank of Schoolhouse Brook. They are bounded to the north by South Vershire Road. These piles, which cover 4.3 acres and are up to 10-12 ft thick, contain Cu-rich residual solid waste generated by the smelting activities that took place at the former smelter plant directly across South Vershire Road. The USGS reported a Cu concentration of 6,750 mg/kg in a composite sample collected from the slag piles (USGS, 2004). Leaching tests performed on these materials also indicated the potential for the release of Cu at concentrations two orders of magnitude above the EPA's ambient water quality criterion for this metal (USGS, 2004).

COPECs leaching out of the slag piles in response to rain or snowmelt are likely to enter Schoolhouse Brook, either directly as overland flow or via local groundwater recharge.

Secondary sources

The following mine-related features have been identified as secondary sources of contamination to the local aquatic environments at Ely Mine.

(e) The former floatation mill

The former floatation mill, built during World War 1, is located just north of the LMWPs. It covers a relatively small area of about 165 ft by 500 ft. The tailings, which were dumped next to the mill, cover an area of about 1,000 ft^2 to a depth of at least 3-4 ft. The whole area is covered by brownish-yellow soil and is mostly devoid of vegetation. The USGS reported a Cu concentration of 2,400 mg/kg in a composited surface soil sample collected from the footprint of the former mill (USGS, 2004). The Cu concentration in a composited soil sample collected from the surface of the tailings themselves equaled 2,240 mg/kg. However, the Cu concentration in a composite sample equaled 25,600 mg/kg in the black, un-oxidized part of the tailings pile 2.5 ft below surface (USGS, 2004).

The former floatation mill is located within 200 ft of both the north and east branch of Ely Brook. It is possible for some of the fine-grained surface tailings at this location to reach one or both of these branches by overland flow during periods of heavy rainfall.

(f) The roast bed complex

The roast bed complex is located along the eastern side of the access road and across from the LMWPs. It covers an area about 985 ft long and 200 ft wide (3.3 acres). This feature is lined by a massive, 600-ft long fieldstone retaining wall which runs alongside the access road. Historically, ore was “roasted” at this location to break down the ore material and drive off excess sulfur prior to smelting. The area supports sparse to minimal vegetation and is covered by a fine to gravelly yellow-orange soil. The USGS reported a Cu concentration of 2,040 mg/kg in a composited surface soil sample collected at this location (USGS, 2004).

A small, ephemeral tributary originates at the southern end of the roast bed complex and flows into the main stem of Ely Brook. It is possible for surface soil to erode from the roast beds and reach the unnamed tributary as overland flow during periods of heavy rainfall.

4.7.1.2 Release and transport mechanisms

Some of the materials present in the mine waste piles at the Site are rich in sulfide minerals (e.g., pyrrhotite, pyrite and chalcopyrite). These minerals react with snowmelt or rainwater and atmospheric oxygen over time. The oxidation process generates sulfuric acid, which causes metals such as Cu and Zn to dissolve out of the mine waste. This highly acidic and metal-rich AMD is toxic to aquatic receptors due to its low pH and high dissolved metal content.

The following release and transport mechanisms may potentially affect the concentration and spatial distribution of COPECs in the waterways at and down-gradient from the Site.

- Dissolution and leaching of COPECs from mine waste into groundwater at the Site,
- Migration of dissolved COPECs in groundwater to sediment and surface water in adjacent surface water bodies, and its attenuation by dilution/dispersion and sorption,
- Transport of COPECs adsorbed to soil particles via surface water runoff,
- Transport of dissolved COPECs in surface water runoff, and
- Trophic transfer of COPECs incorporated in aquatic food chains.

The potential for COPECs to be released from mine waste and transported from the sources at the Site to points of contact with aquatic receptors in the local waterways depends on their chemical speciation, concentration, presence of nearby surface water bodies, extent and duration of precipitation events, and spatial distribution within the mine waste. Surface water runoff and groundwater infiltration are particularly important transport mechanisms for soluble species of metals.

4.7.1.3 Contact point and exposure media

The on-Site ponds, main stem of Ely Brook, Schoolhouse Brook, and the EBOR represent the potential contact points evaluated in the BERA. The potential exposure media are as follows:

- Surface water
- Pore water
- Sediment
- Prey items (e.g., benthic invertebrates, aquatic insects, and fish)

4.7.1.4 Routes of entry

The main routes of entry for aquatic receptors, and terrestrial receptors feeding on aquatic prey, are as follows:

- Direct contact with surface water and sediment via dermal and/or gill absorption (aquatic receptors only).
- Ingestion of surface water (aquatic receptors and terrestrial receptors).
- Ingestion of contaminated prey items (aquatic receptors and terrestrial receptors).

Scientific information from the literature, as well as data from direct toxicity tests and community surveys, were used to assess the potential ecological risks associated with direct contact and ingestion. The BERA evaluates the complete exposure pathways for these two routes of entry. **Exhibit 4.2** summarizes other exposure pathways which were not evaluated in the BERA.

Exhibit 4.2: Exposure pathways not quantitatively evaluated in the aquatic portion of the Ely Copper Mine BERA

Receptors of Concern	Potential Exposure Pathway	Reason for not Evaluating Quantitatively
Aquatic invertebrates and fish	Exposure to COPECs via food chain transfer.	Inadequate information for an independent quantitative evaluation. However, fish tissue residue data integrate all exposure pathways in fish.
Birds and mammals feeding on aquatic prey	Exposure to COPECs via dermal absorption.	Fur and feathers limit direct dermal uptake of COPECs. Preening and grooming was not assumed to represent a significant exposure route to wildlife feeding on aquatic prey in Schoolhouse Brook and the EBOR.
Birds and mammals feeding on aquatic prey	Exposure to COPECs via inhalation	It is assumed that mine-derived inorganics present in sediment do not represent an inhalation threat to wildlife receptors feeding in or over the waterways.
Birds and mammals feeding on aquatic prey	Exposure to COPECs via incidental sediment ingestion	It is assumed that the coarse nature of much of the substrate in Schoolhouse Brook and the EBOR eliminates the incidental ingestion of sediment by wildlife receptors feeding in or over the waterways.

4.7.2 Potential receptors and ecotoxicity

- **Aquatic receptors**

Aquatic invertebrates and fish may live above, on, and/or within the substrate in the three streams affected by AMD runoff. In addition, early life stages of amphibians are present in the on-Site ponds on the east branch of Ely Brook during the spring breeding season.

- **Terrestrial wildlife receptors feeding on aquatic prey**

The following terrestrial wildlife receptors may feed on aquatic prey present in one or more of the affected streams:

- Insectivorous birds and insectivorous mammals can feed on winged aquatic insects, such as adult stoneflies, mayflies, or caddis flies.
- Piscivorous mammals and piscivorous birds can feed on brook trout and other cold-water fish that live in Schoolhouse Brook and the EBOR.

- **Ecotoxicity**

Acidity and metals have been identified as the two major chemical stressors in the aquatic habitats potentially affected by site releases.

Acidity/low pH

Sulfuric acid is released when water and oxygen interact with the sulfide-rich mine waste rock. Low pH is toxic to most aquatic receptors. Sensitive species of fish and aquatic invertebrates experience increased mortality at a pH around 6.0. Brook trout populations disappear from streams when pH drops to the low 5.0's for an extended period of time. The embryo-larval stages of some amphibian species are more resistant to acidity and thrive in *Sphagnum* bogs at pH's in the mid to low 4.0's.

Metals

High acidity solubilizes metals present in the mine waste materials, resulting in metals-enriched surface water run-off. Dissolved metals are of the highest concern because, unlike metals associated with the particulate fraction, they are bioavailable to exert direct toxicity to aquatic receptors, or to move up the aquatic food chain.

Both acidity and dissolved metals affect osmoregulation in aquatic organisms by changing the integrity of the cell junctions in the gill tissues. The cell junctions become "leaky" with increasing levels of H^+ (protons) or metals, thereby allowing blood electrolytes to diffuse out of the gill tissue, and water to diffuse into the bloodstream. Death results when blood electrolytes drop below a critical physiological threshold, which varies from species to species.

4.7.3 Ecosystems potentially at risk

The BERA focuses on aquatic habitats present at or down-gradient from the former Ely Copper Mine Site. The potentially impacted aquatic habitats at the Site consist of the main stem of Ely Brook, and the four on-site ponds on the east branch of Ely Brook. The east branch between the ponds and its confluence with the north branch of Ely Brook, and the network of drainage channels that form the north branch, are excluded from the BERA because they do not represent long-term, viable aquatic habitats.

The potentially impacted aquatic habitats down-gradient from the Site consist of about two miles of Schoolhouse Brook between Ely Brook and the EBOR, and the EBOR below its confluence with Schoolhouse Brook.

4.7.4 Exposure pathways

Routes of exposure are the means by which COPECs can be transferred from a contaminated medium to ecological receptors. The principal Receptors of Concern (ROCs) and routes of exposure evaluated in this BERA are as follows:

- *Benthic invertebrates*: direct contact with sediment and surface water, ingestion of sediment, and ingestion of biota.
- *Water column invertebrates*: direct contact with surface water and ingestion of biota.
- *Fish*: direct contact with sediment and surface water, ingestion of sediment and surface water, and ingestion of biota.
- *Amphibians* (embryo-larval life stages only): direct contact with sediment and surface water, and ingestion of sediment and biota.

- *Insectivorous birds and mammals*: ingestion of surface water and biota (winged aquatic insects).
- *Piscivorous birds and mammals*: ingestion of surface water and biota (benthic invertebrates and fish).

The BERA assumes that sediment ingestion by wildlife receptors is negligible due to the coarse nature of the sediment in Ely Brook, Schoolhouse Brook, and the EBOR. This approach was also used in the Elizabeth Copper Mine BERA (URS, 2006).

4.7.5 Site Conceptual Model

The SCM provides the foundation for performing a BERA. The SCM is formulated based on knowledge of sources, contaminants, complete exposure pathways, and ROCs. The model shows the movement of COPECs from the sources of contamination through the exposure media to the ROCs. **Figure 4.4** presents a simplified SCM for the Site.

The upper and lower mine waste piles at the Site represent the primary sources of contamination to the local water ways. Sulfuric acid is released when water and oxygen interact with the sulfide-rich mine material. This acid dissolves metals. Both enter Ely Brook (including several of the ponds on the east branch of Ely brook) as acidified and metal-enriched surface runoff, leachate, or groundwater (e.g., seeps). Mine waste has also been transported and deposited into Ely Brook itself where it serves as substrate. This material can serve as a secondary source contamination to the local waterways. The surface water in Ely Brook carries high loads of total and dissolved metals, and elevated acidity, into Schoolhouse Brook. A substantial dilution takes place as Schoolhouse Brook flows towards the EBOR.

The biota in the affected aquatic habitats become exposed to mine-derived COPECs by direct contact and/or ingestion. The COPEC concentrations are high enough to make the lower half of Ely Brook essentially devoid of aquatic life, and to significantly affect aquatic life in Schoolhouse Brook up to its confluence with the EBOR. Wildlife receptors along these waterways also have a potential to ingest harmful levels of COPECs by feeding on aquatic receptors (benthic invertebrates, aquatic insects, fish) or by drinking contaminated surface water.

4.8 ASSESSMENT ENDPOINTS, RISK QUESTIONS, MEASUREMENT ENDPOINTS, AND WEIGHT OF EVIDENCE

4.8.1 Introduction

Endpoints help quantify the risks to representative receptors that may be exposed to metals and low pH associated with the Site.

Assessment endpoints represent explicit expressions of the key ecological resources to be protected from harm. They generally reflect sensitive populations, communities, or trophic guilds. Four criteria for selecting the proposed assessment endpoints needed in the Ely Copper Mine BERA are listed below. The ecological resource should:

- have relevance,
- be susceptible to the stressors of concern,
- have biological, social, and/or economic value, and
- be relevant to the risk management goals for the site.

By carefully considering these selection criteria, risks identified to one or more of the assessment endpoints will influence the risk management decision process at the Site.

Measurement endpoints represent measurable ecological characteristics, quantified through laboratory or field experimentation, which can be related back to the valued ecological resources chosen as the assessment endpoints. Measurement endpoints are required because it is often not possible to directly quantify risk to an assessment endpoint. The measurement endpoints should represent the same exposure pathway(s) and mechanisms of toxicity as the assessment endpoints in order to be relevant and useful.

Risk questions establish a link between assessment endpoints and their predicted responses when exposed to COPECs. The risk questions should provide a basis to develop the study design and evaluate the results of the site investigation in the analysis phase and during risk characterization (USEPA, 1997).

4.8.2 <u>Selecting representative assessment endpoint species or communities</u>

It is neither practical nor possible to evaluate the potential for ecological risk to all of the individual parts of the local aquatic ecosystem affected by Site-related chemical stressors. Instead, key components are identified to select those species or groups most likely to experience exposure to the stressors.

4.8.2.1 Non-wildlife receptors

<u>Benthic invertebrates</u>

Benthic invertebrates form an integral link in all aquatic ecosystems. They play a key role in nutrient and energy transfers within those systems. They also process and assimilate organic material, feed on other invertebrates, and are themselves consumed by fish, birds, and mammals.

COPECs with the potential to bioaccumulate can be transferred from the sediment into the benthic invertebrate community and up the food chain, thereby harming higher-level receptors. Significant alterations in invertebrate communities could also impact the energy cycling at the base of the aquatic food chain.

The substrate in the on-site ponds, main stem of Ely Brook, Schoolhouse Brook, and the EBOR should be able to support a diverse benthic invertebrate community. Key invertebrates include snails, freshwater mussels, crayfish, and the aquatic life stages of numerous insect species (e.g., mayflies, stoneflies, caddisflies, dragonflies, etc.).

<u>Water column invertebrates</u>

The water column invertebrate community encompasses zooplankton (mostly crustaceans) commonly found in ponded water bodies. Key species include diving beetles, copepods, and cladocerans. These types of organisms play a role in energy and nutrient transfer to higher trophic levels and also represent a food resource for juvenile amphibians and some benthic invertebrates. The presence of site-derived chemicals in the surface water of the on-site ponds could result in direct mortality or decreased reproduction in water column invertebrates.

<u>Fish</u>

The three streams should be able to support a healthy fish community, consisting of cold water stream species, such as brook trout and dace. The aquatic environment should provide such a community with a diverse food base, suitable feeding and spawning areas, refuges for juvenile fish, and other essential environmental services.

The presence of metals (and high acidity) in the surface water and sediment can impair the local fish community in two general ways: (1) mortality of sensitive early life stages exposed to dissolved metals and/or low pH in the water column, or (2) high metal concentrations in aquatic biota via food chain uptake which could affect reproduction and the long-term survival of the exposed fish.

Repeated visual observations have failed to show the presence of any fish in the on-site ponds. Fish are known to be absent from the main stem of Ely Brook, but are present throughout Schoolhouse Brook and the EBOR.

Amphibians

Amphibians are a key receptor group of concern. Amphibian populations are generally considered to be in broad decline in the U.S. due to habitat loss and environmental degradation. The local amphibian populations at the site extensively use the ponds on the east branch of Ely Brook for breeding in the spring. The conditions in those on-site ponds should be such that amphibian eggs and larvae can survive and develop normally in order to maintain the local amphibian populations.

4.8.2.2 Wildlife receptors

Several bird and mammal species can be expected to forage in the general vicinity of the site and would feed on aquatic prey at Schoolhouse Brook and the EBOR. The main stem of Ely Brook was considered too narrow, shallow, and/or enclosed by forest canopy to represent suitable feeding habitat for wildlife receptors. It also currently does not support aquatic life. The surface area of ponds 2 to 5 combined was too small to provide enough habitat to support insectivores (note: pond 1 was the largest of the five ponds; it was unimpacted and served as an on-Site reference habitat for the ponds). The following target wildlife receptors are evaluated in the BERA.

Tree Swallow (*Tacycineta bicolor*)

The tree swallow is a seasonal resident in northern New England and has been observed in the area around the Site. This bird feeds predominantly on flying insects which it captures in flight over terrestrial, wetland, and riparian areas. Tree swallows migrate south for the winter.

Belted Kingfisher (*Ceryle alcyon*)

The belted kingfisher is a seasonal resident in northern New England, even though it is unknown if it forages in the vicinity of the Site. This piscivorous bird is typically found along the edges of rivers, streams, lakes and ponds. The kingfisher requires shallow water (typically < 60 cm deep) which is free of vegetation and remains relatively clear in order to be able to spot its prey. It feeds predominantly on small fish (< 18 cm). These feeding habits place this receptor high in the food chain. The belted kingfisher migrates south for the winter.

Mink (*Mustela vison*)

The mink is a year-round resident in northern New England, which remains active even during the winter months. It is unknown if mink forage in the vicinity of the Site. This species is associated with aquatic habitats of all kinds, including ponds, lakes, streams, rivers, and wetlands. The mink is an opportunistic carnivore which feeds on a variety of food items, including small mammals and birds, fish, crustaceans, aquatic insects, and amphibians. These feeding habits place it at the top of the food chain.

Eastern small-footed bat (*Myotis leibii*)

The eastern small-footed bat is a year-round resident of the Site, living and possibly hibernating in the old mine shafts at the Site. It feeds exclusively on flying insects and has been observed in the vicinity of the Site.

4.8.3 Endpoint selection

4.8.3.1 Aquatic assessment endpoints and risk questions

The following assessment endpoints were used to evaluate the potential for ecological risks to the aquatic receptors, and wildlife receptors feeding on aquatic prey. A risk question is appended to each assessment endpoint.

It was assumed that by evaluating and protecting the assessment endpoints, all of the aquatic habitats, and the wildlife receptors feeding on them, would be protected as well.

- **A stable and healthy benthic invertebrate community**: *Are the COPEC levels in sediment sufficiently high to cause biologically-significant changes or impair the function of the benthic invertebrate community in the four ponds and the three streams at and down-gradient from the Site?*

- **A stable and healthy water column invertebrate community**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the water column invertebrate community in the four ponds at the Site?*

- **A stable and healthy fish community**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the fish community in the three streams at and down-gradient from the Site?*

- **Stable and healthy amphibian populations**: *Are the dissolved COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the amphibian populations in the four ponds at the Site?*

- **Stable and healthy insectivorous bird populations**: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

- **Stable and healthy insectivorous mammal populations**: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous mammal populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

- **Stable and healthy piscivorous bird populations**: *Are the COPEC levels in surface water and biota sufficiently high to impair piscivorous bird populations foraging in Schoolhouse Brook and the EBOR?*

- **Stable and healthy piscivorous mammal populations**: *Are the COPEC levels in surface water, sediment, and biota sufficiently high to impair piscivorous mammal populations foraging in Schoolhouse Brook and the EBOR?*

4.8.3.2 Aquatic measurement endpoints

Assessment endpoint 1:

A stable and healthy benthic invertebrate community: *Are the COPEC levels in sediment sufficiently high to cause biologically-significant changes or impair the function of the benthic invertebrate community in the four ponds and the three streams at and down-gradient from the Site?*

Depending on the target habitat, the following six measurement endpoints were used to assess the potential impacts of COPECs to this receptor group:

1.A Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.

1.B Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.

1.C Estimate the bioavailability of divalent metals in sediment by comparing AVS to SEM.

1.D Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples.

1.E Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.

1.F Evaluate the structure and function of the benthic invertebrate community.

Assessment endpoint 2:

A stable and healthy water column invertebrate community: *Are the levels of dissolved COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the water column invertebrate community in the four ponds at the Site?*

Two measurement endpoints were used to assess the potential impacts of COPECs to this receptor group:

2.A Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.

2.B Measure survival and reproduction in the water flea, *C. dubia*, exposed for 7 days in the laboratory to surface water samples.

Assessment endpoint 3:

A stable and healthy fish community: *Are the levels of dissolved COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the fish community in the three streams at and down-gradient from the Site?*

Four measurement endpoints were used to assess the potential impacts of COPECs to this receptor group:

3.A Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.

3.B Measure survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.

3.C Compare COPEC levels measured in whole fish to no effect and effect CBRs.

3.D Evaluate the structure and function of the fish community.

<u>Assessment endpoint 4:</u>

Stable and healthy amphibian populations: *Are the levels of dissolved COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the amphibian populations in the four ponds?*

Three measurement endpoints were used to assess the potential impacts of COPECs to this receptor group:

4.A Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.

4.B Measure survival and growth in fathead minnow larvae (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.

4.C Evaluate *in-situ* survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.

<u>Assessment endpoint 5</u>:

Stable and healthy insectivorous bird populations: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

5.A Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water and winged aquatic insects, and compare these values to Toxicity Reference Values (TRVs).

<u>Assessment endpoint 6</u>:

Stable and healthy insectivorous mammal populations: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous mammal populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

6.A Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water and winged aquatic insects, and compare these values to TRVs.

Assessment endpoint 7:

Stable and healthy piscivorous bird populations: *Are the COPEC levels in surface water and biota sufficiently high to impair piscivorous bird populations foraging in Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

7.A Use food chain modeling to calculate daily doses from the ingestion of surface water, benthic invertebrates, and fish, and compare these values to TRVs.

Assessment endpoint 8:

Stable and healthy piscivorous mammal populations: *Are the COPEC levels in surface water, sediment, and biota sufficiently high to impair piscivorous mammal populations foraging in Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

8.A Use food chain modeling to calculate daily doses from the ingestion of surface water and fish, and compare these doses to TRVs.

Exhibit 4.3 summarizes which assessment endpoints were evaluated at each of the four aquatic EUs at the Site.

Exhibit 4.3: Summary of assessment endpoints, exposure units, and receptors of concern for the aquatic portion of the BERA

Assessment Endpoint (viability and function)	Representative species	Aquatic Exposure Units			
		Ponds[a]	Main Stem Ely Brook	Schoolhouse Brook	EBOR[b]
Benthic Invertebrate community	generic	√[c]	√	√	√
Water Column Invertebrate community	generic	√	NA[d]	NA	NA
Fish populations	generic	NA	√	√	√
Amphibian populations	generic	√	NA	NA	NA
Insectivorous birds	tree swallow	NA	NA	√	√
Insectivorous mammals	small-footed bat	NA	NA	√	√

Exhibit 4.3: Summary of assessment endpoints, exposure units, and receptors of concern for the aquatic portion of the BERA					
Piscivorous birds	belted kingfisher	NA	NA	√	√
Piscivorous mammals	mink	NA	NA	√	√

[a] ponds 2 to 5 on the east branch of Ely Brook were considered individual EUs for evaluation in the BERA (pond 1 was a reference location)
[b] EBOR = east branch of the Ompompanoosuc River
[c] √ = the assessment endpoint/EU combination is evaluated in this BERA
[d] NA = not applicable because receptor group is missing (fish in ponds and water column invertebrates plus amphibians in streams) or suitable habitat and/or food sources are unavailable (wildlife receptors at the ponds and Ely Brook)

4.8.4 Weight of evidence

The risk to the target receptor groups identified above was assessed using a WOE approach (Menzie et al., 1996). This method recognized that all measures of effect did not carry the same weight when it came to determining ecological risk. Some measures were quite qualitative (e.g., generic surface water or sediment benchmarks), whereas others were more quantitative (e.g., community surveys). Risk identified based on a qualitative measure of effect had more uncertainty associated with it than risk identified based on more quantitative measures of effect.

A relative weight was assigned to all of the measures of effect before those endpoints were used in risk characterization. Menzie et al. (1996) described ten attributes which, when summed, can help determine the relative weights of all of the measures of effect. **Attachment 4.32** summarizes the BERA endpoints and provides the WOE scoring for each measure of effect used in this BERA. These WOE scores were a key component of the risk integration step described in the risk characterization of the BERA.

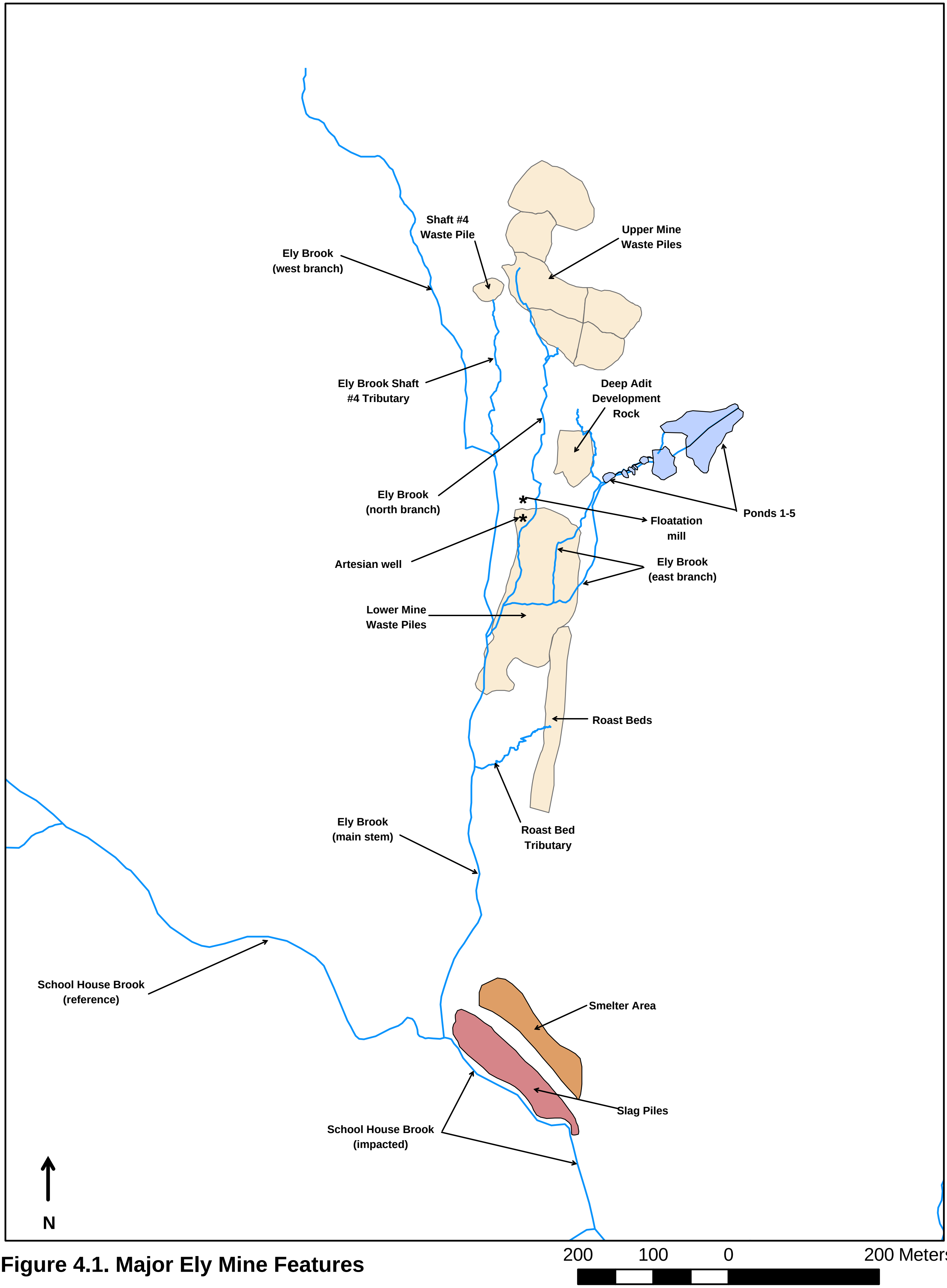


Figure 4.1. Major Ely Mine Features

200 100 0 200 Meters

Figure 4.2: Location of the five ponds on the east branch of Ely Brook

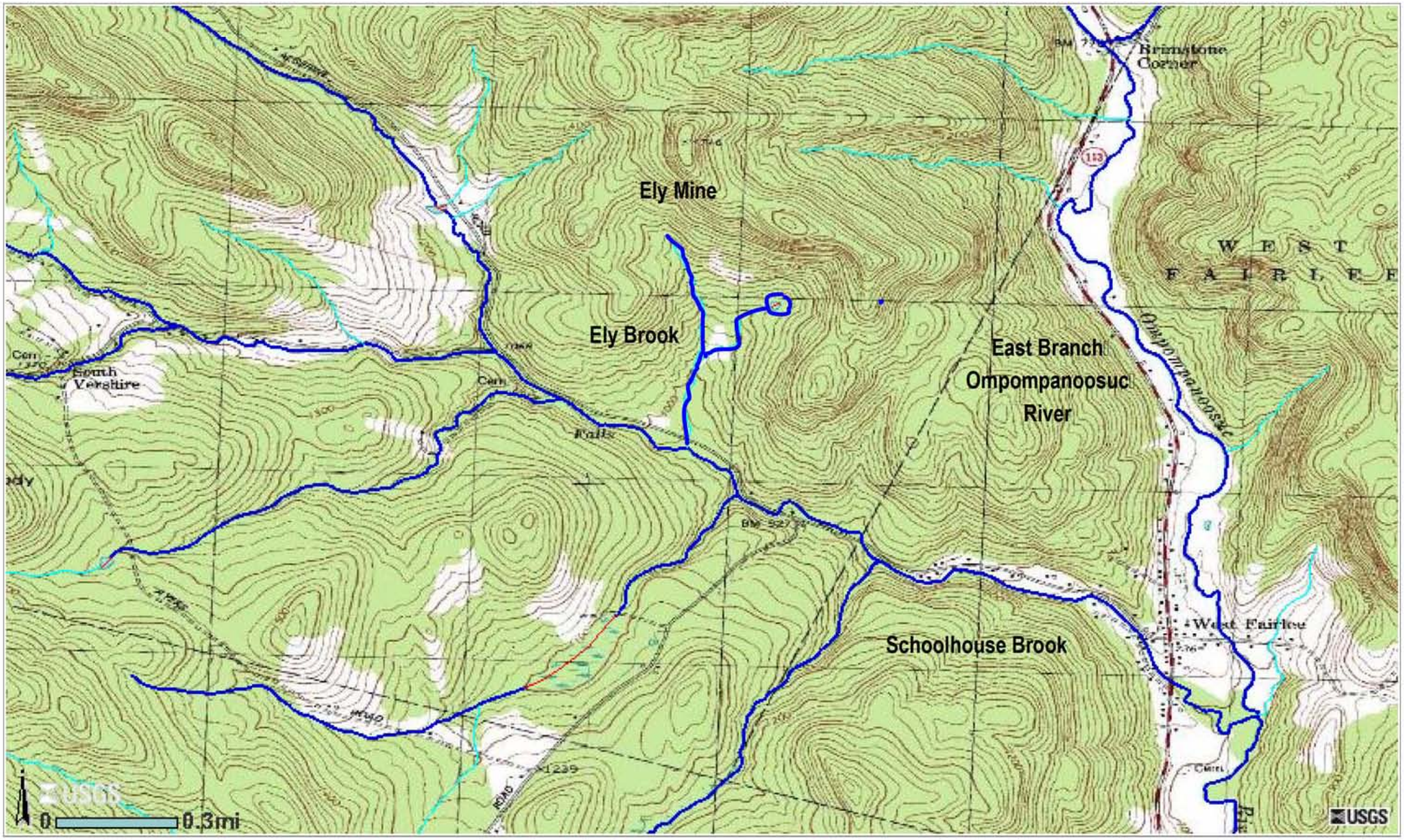


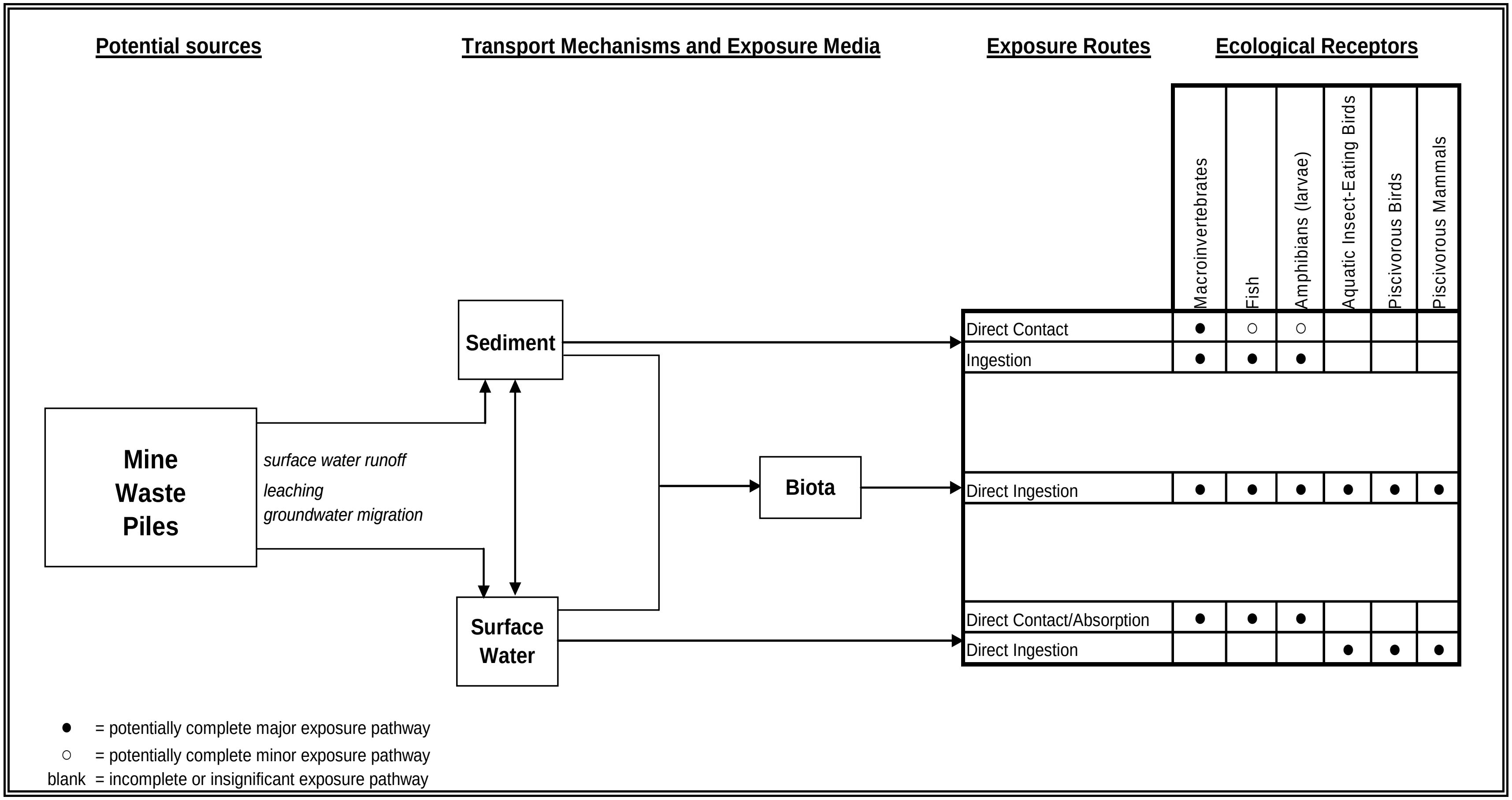
Figure 4.3. Schoolhouse Brook and the East Branch of the Ompompanoosuc River

USGS science for a changing world

The National Map http://nationalmap.gov/

Geographic Coordinate System (WGS84)

Figure 4.4: Site conceptual model for aquatic habitats and receptors at the Ely Copper Mine



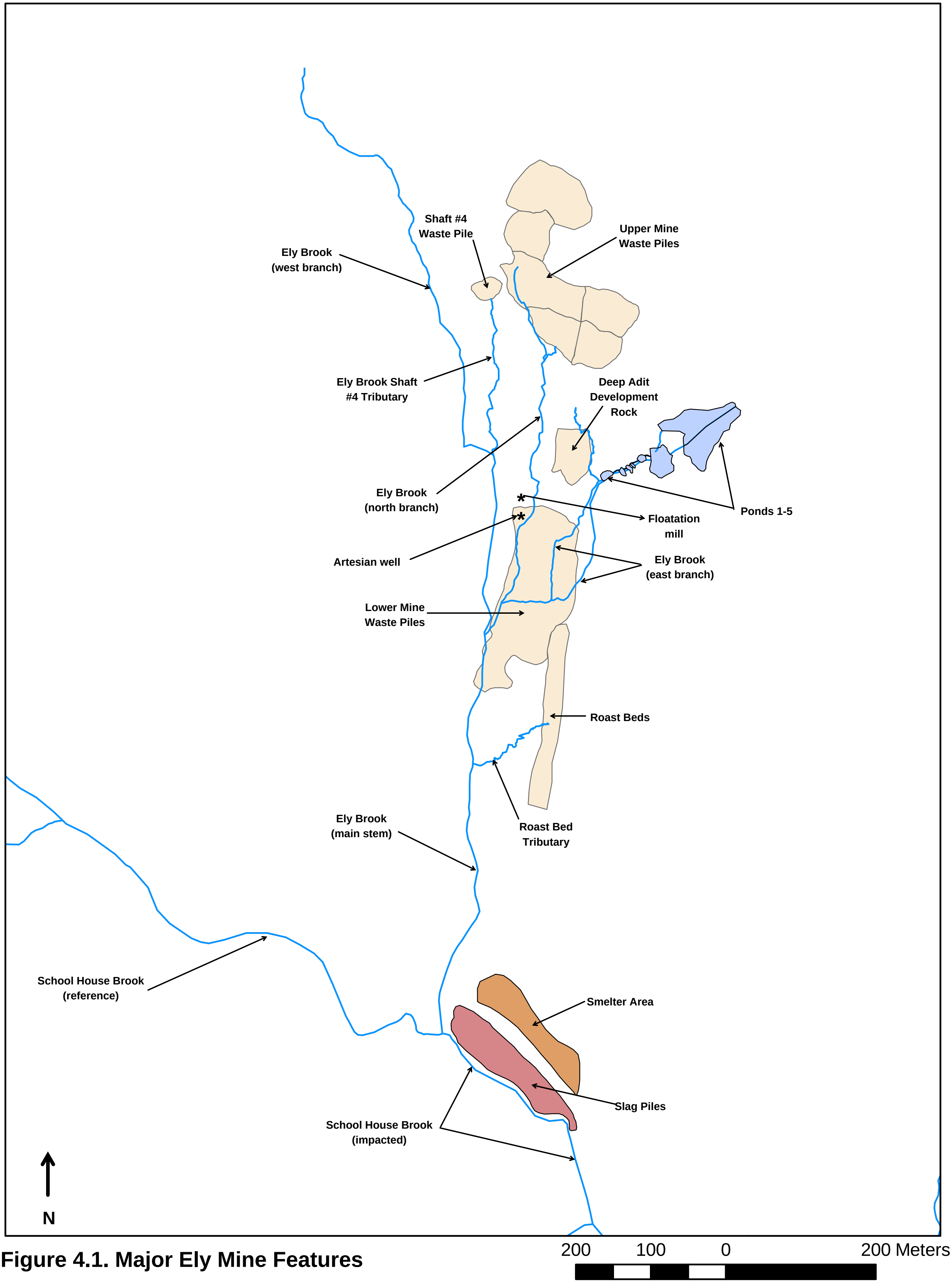


Figure 4.1. Major Ely Mine Features

Figure 4.2: Location of the five ponds on the east branch of Ely Brook

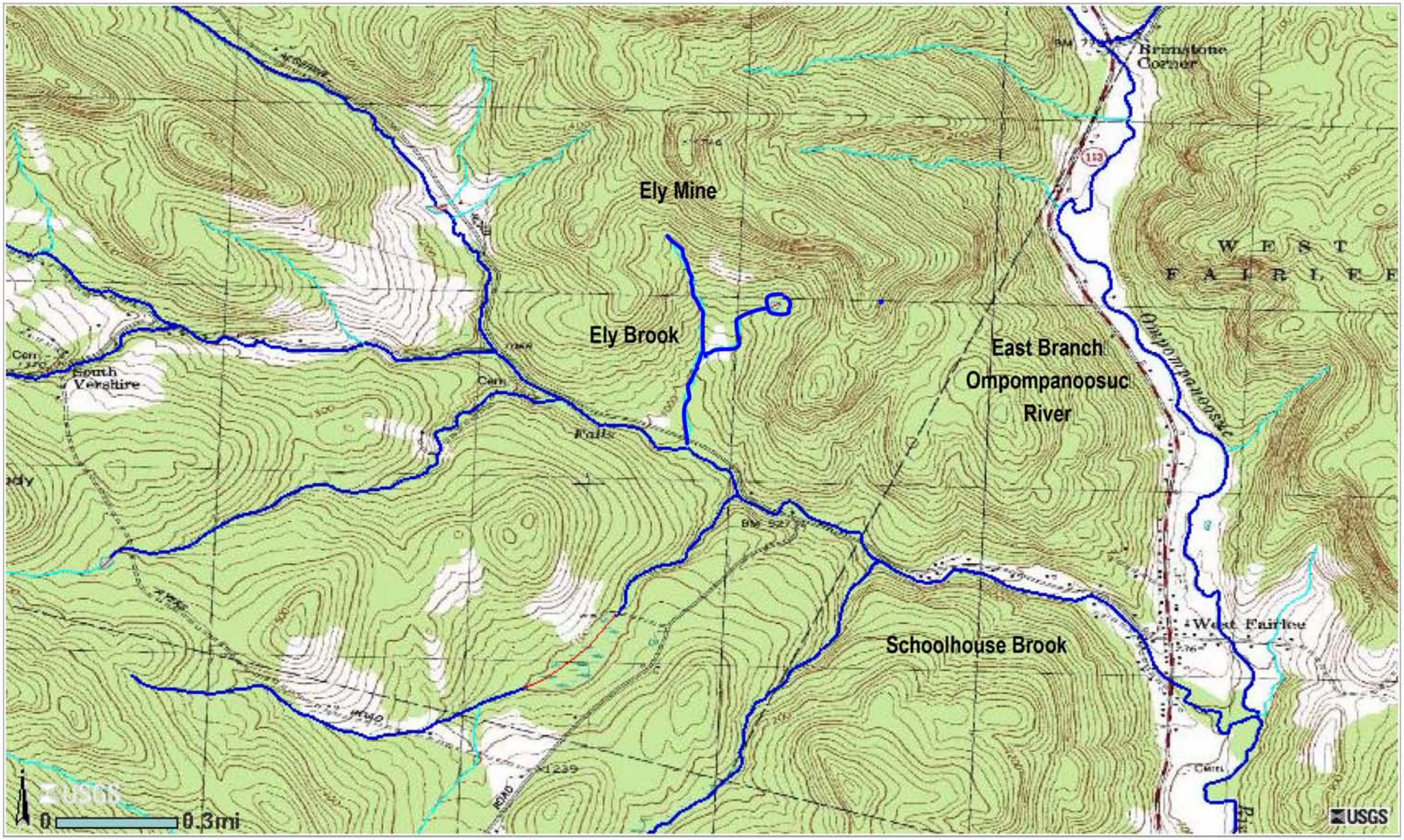


Figure 4.3. Schoolhouse Brook and the East Branch of the Ompompanoosuc River

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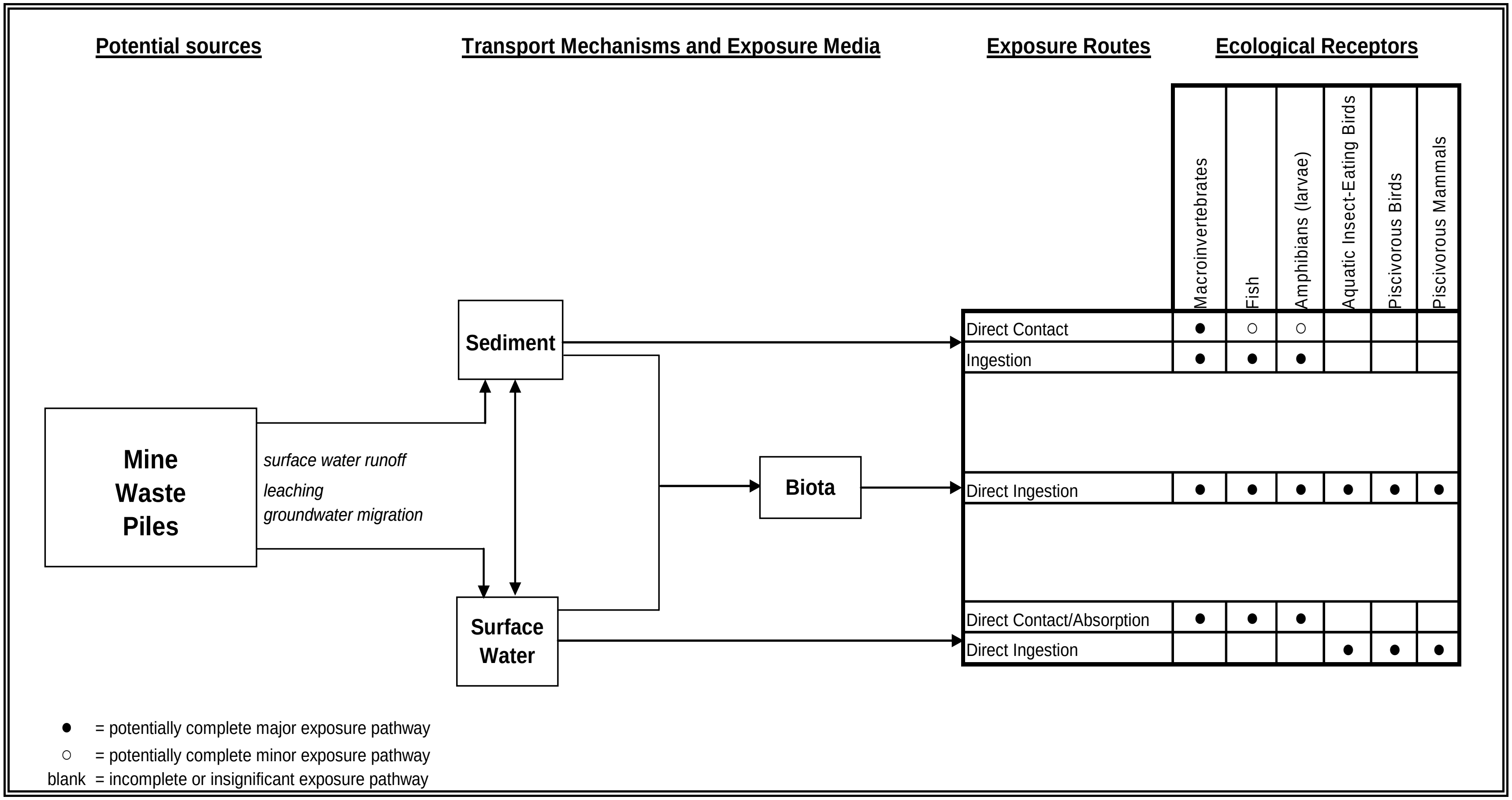
Figure 4.4: Site conceptual model for aquatic habitats and receptors at the Ely Copper Mine



Attachment 4.1
Selection of Sediment COPECs for Benthic Invertebrates in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)											
Antimony	1 / 1	0.11		0.11		0.11	12	(2)	<1	No	(b)
Arsenic	0 / 1	1.0		--		1.0	9.79	(1)	<1	No	(b)
Barium	1 / 1	321		321		321	0.7	(3)	459	**Yes**	(a)
Beryllium	1 / 1	1.8		1.8		1.8	NA		NA	**Yes**	(c)
Cadmium	1 / 1	1.3		1.3		1.3	0.99	(1)	1.3	**Yes**	(a)
Calcium	1 / 1	18900		18900		18900	NA		NA	No	(d)
Chromium	1 / 1	130		130		130	43.4	(1)	3.0	**Yes**	(a)
Cobalt	1 / 1	24.0		24.0		24.0	50	(1)	<1	No	(b)
Copper	1 / 1	87.6		87.6		87.6	31.6	(1)	2.8	**Yes**	(a)
Iron	1 / 1	44800		44800		44800	188400	(3)	<1	No	(b)
Lead	1 / 1	31.8		31.8		31.8	35.8	(1)	<1	No	(b)
Magnesium	1 / 1	13800		13800		13800	NA		NA	No	(d)
Manganese	1 / 1	769		769		769	630	(3)	1.2	**Yes**	(a)
Mercury	1 / 1	0.11		0.11		0.11	0.174	(1)	<1	No	(b)
Molybdenum	1 / 1	2.6		2.6		2.6	NA		NA	**Yes**	(c)
Nickel	1 / 1	45.4		45.4		45.4	22.7	(1)	2.0	**Yes**	(a)
Potassium	1 / 1	10900		10900		10900	NA		NA	No	(d)
Selenium	1 / 1	1.1		1.1		1.1	0.29	(3)	3.8	**Yes**	(a)
Silver	0 / 1	1.0		--		1.0	0.5	(1)	2.0	**Yes**	(a)
Sodium	1 / 1	13000		13000		13000	NA		NA	No	(d)
Strontium	1 / 1	165		165		165	49.0	(3)	3.4	**Yes**	(a)
Tin	1 / 1	2.7		2.7		2.7	5.0	(3)	<1	No	(b)
Vanadium	1 / 1	148		148		148	50	(3)	3.0	**Yes**	(a)
Zinc	1 / 1	131		131		131	121	(1)	1.1	**Yes**	(a)

mg/kg = milligrams per kilogram
COPEC - Chemical of Potential Ecological Concern
NA - Not Available
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.
* - Value represents the maximum non-detect reporting limit (RL), if chemical was not detected.
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.2
Selection of Sediment COPECs for Benthic Invertebrates in Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Parameters	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)											
Antimony	1 / 1	0.30		0.30		0.30	12	(2)	<1	No	(b)
Arsenic	1 / 1	3.0		3.0		3.0	9.79	(1)	<1	No	(b)
Barium	1 / 1	377		377		377	0.7	(3)	539	**Yes**	(a)
Beryllium	1 / 1	1.6		1.6		1.6	NA		NA	**Yes**	(c)
Cadmium	1 / 1	1.2		1.2		1.2	0.99	(1)	1.2	**Yes**	(a)
Calcium	1 / 1	14700		14700		14700	NA		NA	No	(d)
Chromium	1 / 1	85.0		85.0		85.0	43.4	(1)	2.0	**Yes**	(a)
Cobalt	1 / 1	30.9		30.9		30.9	50	(1)	<1	No	(b)
Copper	1 / 1	81.7		81.7		81.7	31.6	(1)	2.6	**Yes**	(a)
Iron	1 / 1	58400		58400		58400	188400	(3)	<1	No	(b)
Lead	1 / 1	43.7		43.7		43.7	35.8	(1)	1.2	**Yes**	(a)
Magnesium	1 / 1	12200		12200		12200	NA		NA	No	(d)
Manganese	1 / 1	3130		3130		3130	630	(3)	5.0	**Yes**	(a)
Mercury	1 / 1	0.15		0.15		0.15	0.174	(1)	<1	No	(b)
Molybdenum	1 / 1	2.2		2.2		2.2	NA		NA	**Yes**	(c)
Nickel	1 / 1	38.6		38.6		38.6	22.7	(1)	1.7	**Yes**	(a)
Potassium	1 / 1	8400		8400		8400	NA		NA	No	(d)
Selenium	1 / 1	1.4		1.4		1.4	0.29	(3)	4.8	**Yes**	(a)
Silver	0 / 1	1.0		--		1.0	0.5	(1)	2.0	**Yes**	(a)
Sodium	1 / 1	9100		9100		9100	NA		NA	No	(d)
Strontium	1 / 1	134		134		134	49.0	(3)	2.7	**Yes**	(a)
Tin	1 / 1	2.5		2.5		2.5	5.0	(3)	<1	No	(b)
Vanadium	1 / 1	125		125		125	50	(3)	2.5	**Yes**	(a)
Zinc	1 / 1	127		127		127	121	(1)	1.0	**Yes**	(a)

mg/kg = milligrams per kilogram
COPEC - Chemical of Potential Ecological Concern
NA - Not Available

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

* - Value represents the maximum non-detect reporting limit (RL), if chemical was not detected.
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.3
Selection of Sediment COPECs for Benthic Invertebrates in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)											
Aluminum	1 / 1	22000		22000		22000	25500	(3)	<1	No	(b)
Antimony	1 / 2	0.31		0.31		0.31	12	(2)	<1	No	(b)
Arsenic	2 / 2	2.6		7.0		7.0	9.79	(1)	<1	No	(b)
Barium	2 / 2	100		337		337	0.7	(3)	481	**Yes**	(a)
Beryllium	1 / 2	1.6		1.6		1.6	NA		NA	**Yes**	(c)
Cadmium	2 / 2	1.1	J	2.5		2.5	0.99	(1)	2.5	**Yes**	(a)
Calcium	2 / 2	2400		11100		11100	NA		NA	No	(d)
Chromium	2 / 2	60.0	J	67.0		67.0	43.4	(1)	1.5	**Yes**	(a)
Cobalt	2 / 2	29.2		38.0		38.0	50	(1)	<1	No	(b)
Copper	2 / 2	380		400		400	31.6	(1)	12.7	**Yes**	(a)
Iron	2 / 2	30000		38800		38800	188400	(3)	<1	No	(b)
Lead	2 / 2	9.3	J	20.2		20.2	35.8	(1)	<1	No	(b)
Magnesium	2 / 2	10000	J	12500		12500	NA		NA	No	(d)
Manganese	2 / 2	920	J	2410		2410	630	(3)	3.8	**Yes**	(a)
Mercury	2 / 2	0.04	J	0.09		0.09	0.174	(1)	<1	No	(b)
Molybdenum	2 / 2	1.1	J	1.8		1.8	NA		NA	**Yes**	(c)
Nickel	2 / 2	56.0		61.1		61.1	22.7	(1)	2.7	**Yes**	(a)
Potassium	2 / 2	3100		11100		11100	NA		NA	No	(d)
Selenium	2 / 2	0.70		1.3	J	1.3	0.29	(3)	4.5	**Yes**	(a)
Silver	0 / 2	2.4		--		2.4	0.5	(1)	4.8	**Yes**	(a)
Sodium	1 / 2	6900		6900		6900	NA		NA	No	(d)
Strontium	1 / 1	91.9		91.9		91.9	49.0	(3)	1.9	**Yes**	(a)
Thallium	0 / 1	2.4		--		2.4	NA		NA	**Yes**	(c)
Tin	1 / 1	1.9		1.9		1.9	5.0	(3)	<1	No	(b)
Vanadium	2 / 2	58.0	J	93.0		93.0	50	(3)	1.9	**Yes**	(a)
Zinc	2 / 2	316		320	J	320	121	(1)	2.6	**Yes**	(a)

mg/kg = milligrams per kilogram
COPEC - Chemical of Potential Ecological Concern
NA - Not available
* - Value represents the maximum non-detect reporting limit (RL), if chemical was not detected.
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.4
Selection of Sediment COPECs for Benthic Invertebrates in Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)											
Antimony	1 / 1	0.97		0.97		0.97	12	(2)	<1	No	(b)
Arsenic	1 / 1	3.0		3.0		3.0	9.79	(1)	<1	No	(b)
Barium	1 / 1	296		296		296	0.7	(3)	423	**Yes**	(a)
Beryllium	1 / 1	1.6		1.6		1.6	NA		NA	**Yes**	(c)
Cadmium	1 / 1	4.0		4.0		4.0	0.99	(1)	4.0	**Yes**	(a)
Calcium	1 / 1	9200		9200		9200	NA		NA	No	(d)
Chromium	1 / 1	70.0		70.0		70.0	43.4	(1)	1.6	**Yes**	(a)
Cobalt	1 / 1	78.3		78.3		78.3	50	(1)	1.6	**Yes**	(a)
Copper	1 / 1	3540		3540		3540	31.6	(1)	112	**Yes**	(a)
Iron	1 / 1	49900		49900		49900	188400	(3)	<1	No	(b)
Lead	1 / 1	23.5		23.5		23.5	35.8	(1)	<1	No	(b)
Magnesium	1 / 1	10200		10200		10200	NA		NA	No	(d)
Manganese	1 / 1	1430		1430		1430	630	(3)	2.3	**Yes**	(a)
Mercury	1 / 1	0.09		0.09		0.09	0.174	(1)	<1	No	(b)
Molybdenum	1 / 1	2.5		2.5		2.5	NA		NA	**Yes**	(c)
Nickel	1 / 1	56.8		56.8		56.8	22.7	(1)	2.5	**Yes**	(a)
Potassium	1 / 1	7900		7900		7900	NA		NA	No	(d)
Selenium	1 / 1	1.3		1.3		1.3	0.29	(3)	4.5	**Yes**	(a)
Silver	0 / 1	1.0		--		1.0	0.5	(1)	2.0	**Yes**	(a)
Sodium	1 / 1	8900		8900		8900	NA		NA	No	(d)
Strontium	1 / 1	76.5		76.5		76.5	49.0	(3)	1.6	**Yes**	(a)
Tin	1 / 1	1.6		1.6		1.6	5.0	(3)	<1	No	(b)
Vanadium	1 / 1	79.0		79.0		79.0	50	(3)	1.6	**Yes**	(a)
Zinc	1 / 1	507		507		507	121	(1)	4.2	**Yes**	(a)

mg/kg = milligrams per kilogram
COPEC - Chemical of Potential Ecological Concern
NA - Not Available

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

* - Value represents the maximum non-detect reporting limit (RL), if chemical was not detected.
(a) The maximum concentration exceeded its benchmark
(b) The maximum concentration did not exceed its benchmark
(c) No benchmark was available
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001)

Attachment 4.5
Selection of Sediment COPECs for Benthic Invertebrates in the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemical	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)													
Aluminum	26 / 26	100%	1100		16000		EB-30M	16000	25500	(3)	<1	No	(b)
Antimony	4 / 30	13%	0.29		2.0		EB-90M	2.0	12	(2)	<1	No	(b)
Arsenic	22 / 31	71%	0.29	J	6.0		EB-90M	6.0	9.79	(1)	<1	No	(b)
Barium	32 / 32	100%	18.0		236		EB-600M	236	0.7	(3)	337	**Yes**	(a)
Beryllium	7 / 32	22%	0.30	J	2.0		EB-535M EB-15M	2.0	NA		NA	**Yes**	(c)
Cadmium	9 / 12	--	0.31	J	3.2	J	EB-30M	3.2	0.99	(1)	3.2	**Yes**	(a)
Calcium	32 / 32	100%	54.0		16200		EB-15M	16200	NA		NA	No	(d)
Chromium	32 / 32	100%	7.2	J	83.0		EB-15M	83.0	43.4	(1)	1.9	**Yes**	(a)
Cobalt	32 / 32	100%	5.8		140		EB-30M	140	50	(1)	2.8	**Yes**	(a)
Copper	32 / 32	100%	310		6600		EB-405M	6600	31.6	(1)	209	**Yes**	(a)
Iron	32 / 32	100%	57000		400000		EB-210M	400000	188400	(3)	2.1	**Yes**	(a)
Lead	30 / 32	94%	8.7	J	174		EB-600M	174	35.8	(1)	4.9	**Yes**	(a)
Magnesium	32 / 32	100%	380		10500		EB-600M	10500	NA		NA	No	(d)
Manganese	32 / 32	100%	5.6		2080		EB-90M	2080	630	(3)	3.3	**Yes**	(a)
Mercury	20 / 30	67%	0.01	J	0.12		EB-30M	0.12	0.174	(1)	<1	No	(b)
Molybdenum	30 / 30	100%	2.1	J	26.0		EB-535M	26.0	NA		NA	**Yes**	(c)
Nickel	31 / 32	97%	0.90	J	35.0		EB-30M	35.0	22.7	(1)	1.5	**Yes**	(a)
Potassium	30 / 30	100%	2200		10500		EB-600M	10500	NA		NA	No	(d)
Selenium	30 / 30	100%	8.1		44.0		EB-30M	44.0	0.29	(3)	152	**Yes**	(a)
Silver	27 / 31	87%	0.47	J	13.0	J	EB-30M	13.0	0.5	(1)	26	**Yes**	(a)
Sodium	30 / 30	100%	72.0	J	16740		EB-15M	16740	NA		NA	No	(d)
Strontium	6 / 6	--	57.7		123		EB-15M	123	49.0	(3)	2.5	**Yes**	(a)
Thallium	7 / 26	27%	0.45	J	3.3	J	EB-530M	3.3	NA		NA	**Yes**	(c)
Vanadium	32 / 32	100%	30.0	J	112		EB-20M EB-535M EB-90M	112	50	(3)	2.2	**Yes**	(a)
Zinc	32 / 32	100%	39.0		410		EB-30M	410	121	(1)	3.4	**Yes**	(a)

COPEC - Chemical of Potential Ecological Concern
NA - Not available

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.6
Selection of Sediment COPECs for Benthic Invertebrates in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)													
Aluminum	28 / 28	100%	3200		12000		SB-1360M	12000	25500	(3)	<1	No	(b)
Antimony	5 / 33	15%	0.65		2.4		SB-3260M	2.4	12	(2)	<1	No	(b)
Arsenic	31 / 34	91%	0.33	J	12.0		SB-3245M	12.0	9.79	(1)	1.2	**Yes**	(a)
Barium	34 / 34	100%	20.0		199		SB-140M	199	0.7	(3)	284	**Yes**	(a)
Beryllium	7 / 34	21%	0.10	J	2.0		SB-3245M	2.0	NA		NA	**Yes**	(c)
Cadmium	11 / 34	32%	0.10		0.49	J	SB-20M	0.49	0.99	(1)	<1	No	(b)
Calcium	34 / 34	100%	2200		27250		SB-3245M	27250	NA		NA	No	(d)
Chromium	34 / 34	100%	7.1	J	85.0		SB-3245M	85.0	43.4	(1)	2.0	**Yes**	(a)
Cobalt	34 / 34	100%	5.2		93.0		SB-3020M	93.0	50	(1)	1.9	**Yes**	(a)
Copper	34 / 34	100%	44.0		1390		SB-3260M	1390	31.6	(1)	44	**Yes**	(a)
Iron	34 / 34	100%	8500	J	58800		SB-3260M	58800	188400	(3)	<1	No	(b)
Lead	31 / 34	91%	2.2	J	31.4		SB-140M	31.4	35.8	(1)	<1	No	(b)
Magnesium	34 / 34	100%	1500	J	7850		SB-3245M	7850	NA		NA	No	(d)
Manganese	34 / 34	100%	200	J	1400		SB-3245M	1400	630	(3)	2.2	**Yes**	(a)
Mercury	9 / 31	29%	0.01	J	0.02	J	SB-2900M	0.02	0.174	(1)	<1	No	(b)
Molybdenum	29 / 30	97%	0.16	J	7.3		SB-3260M	7.3	NA		NA	**Yes**	(c)
Nickel	34 / 34	100%	6.7		22.0		SB-3245M	22.0	22.7	(1)	<1	No	(b)
Potassium	31 / 31	100%	840		9200		SB-140M	9200	NA		NA	No	(d)
Selenium	29 / 33	88%	0.19	J	9.8		SB-3260M	9.8	0.29	(3)	34	**Yes**	(a)
Silver	11 / 34	32%	0.16	J	0.49	J	SB-1140M	0.49	0.5	(1)	<1	No	(b)
Sodium	31 / 31	100%	46.0	J	977		SB-3245M	977	NA		NA	No	(d)
Strontium	6 / 6	--	164		228		SB-3245M	228	49.0	(3)	4.7	**Yes**	(a)
Thallium	0 / 28	0%	50.0		--			--	NA		NA	No	(e)
Vanadium	34 / 35	97%	9.2	J	62.0		SB-3260M	62.0	50	(3)	1.2	**Yes**	(a)
Zinc	34 / 34	100%	21.0	J	130	J	SB-20M	130	121	(1)	1.1	**Yes**	(a)

mg/kg - milligrams per kilogram
COPEC - Chemical of Potential Ecological Concern
NA - Not Available
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.
* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).
(e) The compound is present above its RL in less than 5% of the samples and the number of samples collected exceeds 20.

Attachment 4.7
Selection of Sediment COPECs for Benthic Invertebrates in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals (mg/kg)												
Aluminum	16 / 16	4600		14000		OR-20200M OR-23650M	14000	25500	(3)	<1	No	(b)
Antimony	2 / 17	0.22		1.8	J	OR-11850M	1.8	12	(2)	<1	No	(b)
Arsenic	10 / 17	0.47	J	5.0		OR-23200M	5.0	9.79	(1)	<1	No	(b)
Barium	17 / 17	23.0		195		OR-23200M	195	0.7	(3)	279	**Yes**	(a)
Beryllium	4 / 17	0.05	J	1.8		OR-23200M	1.8	NA		NA	**Yes**	(c)
Cadmium	2 / 17	0.10		0.18	J	OR-23630M	0.18	0.99	(1)	<1	No	(b)
Calcium	17 / 17	1900		13000		OR-23200M	13000	NA		NA	No	(d)
Chromium	17 / 17	11.0	J	31.5		OR-11850M	31.5	43.4	(1)	<1	No	(b)
Cobalt	17 / 17	2.5		28.5		OR-8350M	28.5	50	(1)	<1	No	(b)
Copper	17 / 17	4.2		260		OR-23630M	260	31.6	(1)	8.2	**Yes**	(a)
Iron	17 / 17	5100	J	22800		OR-23200M	22800	188400	(3)	<1	No	(b)
Lead	14 / 17	0.63	J	11.0		OR-23630M	11.0	35.8	(1)	<1	No	(b)
Magnesium	17 / 17	1900	J	8000		OR-20200M	8000	NA		NA	No	(d)
Manganese	17 / 17	138		1120		OR-23200M	1120	630	(3)	1.8	**Yes**	(a)
Mercury	2 / 14	0.01	J	0.02	J	OR-23650M	0.02	0.174	(1)	<1	No	(b)
Molybdenum	8 / 10	0.11	J	1.1	J	OR-23630M	1.1	NA		NA	**Yes**	(c)
Nickel	17 / 17	7.4		21.0		OR-20200M OR-23650M	21.0	22.7	(1)	<1	No	(b)
Potassium	14 / 14	830	J	8400		OR-23200M	8400	NA		NA	No	(d)
Selenium	3 / 17	0.30		0.81	J	OR-23630M	0.81	0.29	(3)	2.8	**Yes**	(a)
Silver	2 / 17	0.46	J	0.57	J	OR-8350M	0.57	0.5	(1)	1.1	**Yes**	(a)
Sodium	13 / 13	48.0	J	7600		OR-23200M	7600	NA		NA	No	(d)
Strontium	1 / 1	193		193		OR-23200M	193	49.0	(3)	3.9	**Yes**	(a)
Thallium	0 / 16	27.5		--			27.5	NA		NA	**Yes**	(c)
Vanadium	17 / 17	9.4	J	49.0		OR-23200M	49.0	50	(3)	<1	No	(b)
Zinc	17 / 17	13.0	J	125		OR-8350M	125	121	(1)	1.0	**Yes**	(a)

COPEC - Chemical of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
NA - Not Available

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

* - If the chemical was not detected than this value represents the maximum non-detect reporting limit (RL)

J = estimated value

(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.8
Summary of Sediment COPECs for Benthic Invertebrates
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	Ponds						
COPEC	**2**	**3**	**4**	**5**	**Ely Brook**	**School House Brook**	**The EBOR**
Arsenic						√	
Barium	√	√	√	√	√	√	√
Beryllium	√	√	√	√	√	√	√
Cadmium	√	√	√	√	√		
Chromium	√	√	√	√	√	√	
Cobalt				√	√	√	
Copper	√	√	√	√	√	√	√
Iron					√		
Lead		√			√		
Manganese	√	√	√	√	√	√	√
Molybdenum	√	√	√	√	√	√	√
Nickel	√	√	√	√	√		
Selenium	√	√	√	√	√	√	√
Silver	√	√	√	√	√		√
Strontium	√	√	√	√	√	√	√
Thallium			√		√		√
Vanadium	√	√	√	√	√	√	
Zinc	√	√	√	√	√	√	√

√ - Chemical was selected as a COPEC

Attachment 4.9
Selection of Pore Water COPECs for the Main Stem of Ely Book
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)												
Aluminum	6 / 6	4.8		456		EB-600M	456	87	(1)	5.2	**Yes**	(a)
Antimony	0 / 6	50.0		--			50.0	80	(4)	<1	No	(b)
Arsenic	0 / 6	200		--			200	150	(1)	1.3	**Yes**	(a)
Barium	6 / 6	14.0		86.0		EB-770M	86.0	220	(4)	<1	No	(b)
Beryllium	0 / 6	10.0		--			10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	6 / 6	0.03		2.0		EB-770M	2.0	0.25	(1)	7.8	**Yes**	(a)
Calcium	6 / 6	14300		56100		EB-770M	56100	NA		NA	No	(d)
Chromium	0 / 6	10.0		--			10.0	11	(1)	<1	No	(b)
Cobalt	6 / 6	2.2		95.0		EB-770M	95.0	24	(4)	4.0	**Yes**	(a)
Copper	6 / 6	0.77		131		EB-770M	131	9.0	(1)	15	**Yes**	(a)
Iron	5 / 6	32.0		747		EB-770M	747	1000	(1)	<1	No	(b)
Lead	2 / 6	0.05		0.10		EB-770M	0.10	2.5	(1)	<1	No	(b)
Magnesium	6 / 6	2290		9290		EB-770M	9290	NA		NA	No	(d)
Manganese	6 / 6	17.0		6590		EB-770M	6590	120	(6)	55	**Yes**	(a)
Mercury	0 / 2	5.0		--			5.0	0.77	(1)	6.5	**Yes**	(a)
Molybdenum	0 / 6	20.0		--			20.0	370	(6)	<1	No	(b)
Nickel	6 / 6	0.22		24.0		EB-770M	24.0	52	(1)	<1	No	(b)
Potassium	6 / 6	2130		7320		EB-770M	7320	NA		NA	No	(d)
Selenium	2 / 6	1.0		1.2		EB-770M	1.2	5.0	(1)	<1	No	(d)
Sodium	6 / 6	1400		3510		EB-770M	3510	NA		NA	No	(d)
Strontium	6 / 6	51.0		212		EB-770M	212	1500	(6)	<1	**Yes**	(b)
Thallium	0 / 6	0.10		--			0.10	40	(5)	<1	No	(d)
Vanadium	0 / 6	10.0		--			10.0	12	(4)	<1	No	(b)
Zinc	6 / 6	0.87		126		EB-770M	126	120	(1)	1.1	**Yes**	(a)

ug/L - micrograms per liter
COPEC - Chemical of Potential Ecological Concern
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.10
Selection of Pore Water COPECs for School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)												
Aluminum	9 / 9	8.5		202		SB-2400M	202	87	(1)	2.3	**Yes**	(a)
Antimony	4 / 9	0.30		0.53		SB-2400M	0.53	80	(4)	<1	No	(b)
Arsenic	0 / 9	200		--			200	150	(1)	1.3	**Yes**	(a)
Barium	9 / 9	20.0		88.0		SB-140M	88.0	220	(4)	<1	No	(b)
Beryllium	0 / 9	10.0		--			10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	9 / 9	0.02		0.30		SB-2400M	0.30	0.25	(1)	1.2	**Yes**	(a)
Calcium	9 / 9	34600		93600		SB-1360M	93600	NA		--	No	(d)
Chromium	0 / 9	10.0		--			10.0	11	(1)	<1	No	(b)
Cobalt	9 / 9	0.03		4.3		SB-1360M	4.3	24	(4)	<1	No	(b)
Copper	9 / 9	0.76		25.0		SB-1360M	25.0	9.0	(1)	2.8	**Yes**	(a)
Iron	4 / 8	28.0		213		SB-2400M	213	1000	(1)	<1	No	(b)
Lead	7 / 9	0.003		0.20		SB-1360M SB-140M	0.20	2.5	(1)	<1	No	(b)
Magnesium	9 / 9	1950		6210		SB-2400M	6210	NA		--	No	(d)
Manganese	9 / 9	0.60		2030		SB-1360M	2030	120	(6)	17	**Yes**	(a)
Mercury	0 / 3	5.0		--			5.0	0.77	(1)	6.5	No	(b)
Molybdenum	0 / 9	20.0		--			20.0	370	(6)	<1	No	(b)
Nickel	9 / 9	0.07		2.6		SB-140M	2.6	52	(1)	<1	No	(b)
Potassium	2 / 2	#REF!		#REF!		SB-2400M	#REF!	NA		--	No	(d)
Selenium	8 / 9	1.3		7.4		SB-1360M	7.4	5.0	(1)	1.5	**Yes**	(a)
Sodium	6 / 9	1000		4470		SB-1360M	4470	NA		--	No	(d)
Strontium	9 / 9	5.5		242		SB-1360M	242	1500	(6)	<1	No	(b)
Thallium	7 / 9	184		470		SB-140M	470	40	(5)	12	**Yes**	(a)
Vanadium	1 / 9	0.10		0.10		SB-2400M	0.10	12	(4)	<1	No	(b)
Zinc	2 / 9	0.95		149		SB-1360M	149	120	(1)	1.2	**Yes**	(a)

COPEC - Chemical of Potential Ecological Concern
ug/L - micrograms per liter
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

J - estimated value
* - If sample was not detected, value represents the maximum non-detect reporting limit (RL)
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.11
Selection of Pore Water COPECs for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)												
Aluminum	3 / 3	11.6		49.0		OR-11850M	49.0	87	(1)	<1	No	(b)
Antimony	0 / 3	50.0		--			50.0	80	(4)	<1	No	(b)
Arsenic	0 / 3	200		--			200	150	(1)	1.3	**Yes**	(a)
Barium	3 / 3	23.0		85.0		OR-11850M	85.0	220	(4)	<1	No	(b)
Beryllium	0 / 3	10.0		--			10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	3 / 3	0.002		0.06		OR-11800M	0.06	0.25	(1)	<1	No	(b)
Calcium	3 / 3	35800		86800		OR-11850M	86800	NA			No	(d)
Chromium	1 / 3	1.9		1.9		OR-11800M	1.9	11	(1)	<1	No	(b)
Cobalt	3 / 3	0.47		3.08		OR-11850M	3.1	24	(4)	<1	No	(b)
Copper	3 / 3	0.26		4.5		OR-11800M	4.5	9.0	(1)	<1	No	(b)
Iron	2 / 3	23.0		184		OR-11800M	184	1000	(1)	<1	No	(b)
Lead	3 / 3	0.002		0.3		OR-11800M	0.30	2.5	(1)	<1	No	(b)
Magnesium	3 / 3	1470		4040		OR-11850M	4040	NA			No	(d)
Manganese	3 / 3	364		3700		OR-11850M	3700	120	(6)	30.8	**Yes**	(a)
Mercury	0 / 1	5.0		--			5.0	0.77	(1)	6.5	**Yes**	(a)
Molybdenum	0 / 3	20.0		--			20.0	370	(6)	<1	No	(b)
Nickel	3 / 3	0.03		0.80		OR-11800M	0.80	52	(1)	<1	No	(b)
Potassium	3 / 3	3180		5460		OR-11850M	5460	NA			No	(d)
Selenium	0 / 3	1.0		--			1.0	5.0	(1)	<1	No	(b)
Sodium	3 / 3	9560		16800		OR-11850M	16800	NA			No	(d)
Strontium	3 / 3	165		399		OR-11850M	399	1500	(6)	<1	No	(b)
Thallium	0 / 2	0.10		--			0.10	40	(5)	<1	No	(b)
Vanadium	1 / 3	1.0		1.0		OR-11850M	1.0	12	(4)	<1	No	(b)
Zinc	3 / 3	0.08		2.9		OR-11800M	2.9	120	(1)	<1	No	(b)

ug/L - microgram per liter
COPEC - Chemical of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.
* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.12
Summary of Pore Water COPECs
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Ely Brook	School House Brook	The EBOR
Aluminum	√	√	
Arsenic	√	√	√
Beryllium	√	√	√
Cadmium	√	√	
Cobalt	√		
Copper	√	√	
Manganese	√	√	√
Mercury	√		√
Selenium		√	
Strontium	√		
Thallium		√	
Zinc	√	√	

√ - Chemical was selected as a COPEC

Attachment 4.13
Selection of Surface Water COPECs for Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)											
Aluminum	6 / 6	4.5		12.0		12.0	87	(1)	<1	No	(b)
Antimony	3 / 6	0.42		1.1		1.1	80	(4)	<1	No	(b)
Arsenic	1 / 6	1.0		1.0		1.0	150	(1)	<1	No	(b)
Barium	6 / 6	14.0		31.0		31.0	220	(4)	<1	No	(b)
Beryllium	0 / 6	10.0		--		10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	2 / 6	0.06		0.15		0.15	0.25	(1)	<1	No	(b)
Calcium	6 / 6	4500		13600		13600	NA		NA	No	(d)
Chromium	1 / 6	6.6		6.6		6.6	11	(1)	<1	No	(b)
Cobalt	6 / 6	0.02		0.66		0.66	24	(4)	<1	No	(b)
Copper	6 / 6	1.5		41.8		41.8	9.0	(1)	4.6	**Yes**	(a)
Iron	6 / 6	41		560		560	1000	(1)	<1	No	(b)
Lead	3 / 6	0.47		0.64		0.64	2.5	(1)	<1	No	(b)
Magnesium	6 / 6	740		1700		1700	NA		NA	No	(d)
Manganese	6 / 6	20.0		1400		1400	120	(6)	11.7	**Yes**	(a)
Molybdenum	5 / 6	0.10		1.0		1.0	370	(6)	<1	No	(b)
Nickel	5 / 6	0.58		2.41		2.4	52	(1)	<1	No	(b)
Potassium	6 / 6	1100		2100		2100	NA		NA	No	(d)
Selenium	1 / 6	0.50		0.50		0.50	5.0	(1)	<1	No	(b)
Silver	3 / 6	0.15		0.49		0.49	0.32	(1)	1.5	**Yes**	(a)
Sodium	6 / 6	920		1600		1600	NA		NA	No	(d)
Strontium	6 / 6	18.0		57.0		57.0	1500	(6)	<1	No	(b)
Thallium	0 / 6	0.10		--		0.10	40	(5)	<1	No	(b)
Vanadium	5 / 6	0.10		0.70		0.70	12	(4)	<1	No	(b)
Zinc	6 / 6	5.5		171		171	120	(1)	1.4	**Yes**	(a)

ug/L = micrograms per liter
COPEC - Chemical of Potential Ecological Concern
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
(a) The maximum concentration exceeded its benchmark
(b) The maximum concentration did not exceed its benchmark
(c) No benchmark was available
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001)

Attachment 4.14
Selection of Surface Water COPECs for Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Parameters	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)											
Aluminum	1 / 1	6.2		6.2		6.2	87	(1)	<1	No	(b)
Antimony	1 / 1	0.62		0.62		0.62	80	(4)	<1	No	(b)
Arsenic	0 / 1	200		--		200	150	(1)	1.3	**Yes**	(a)
Barium	1 / 1	13.0		13.0		13.0	220	(4)	<1	No	(b)
Beryllium	0 / 1	10.0		--		10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	0 / 1	13.0		--		13.0	0.25	(1)	52	**Yes**	(a)
Calcium	1 / 1	9060		9060		9060	NA		NA	No	(d)
Chromium	0 / 1	28.8		--		28.8	11	(1)	2.6	**Yes**	(a)
Cobalt	1 / 1	0.23		0.23		0.23	24	(4)	<1	No	(b)
Copper	1 / 1	1.7		1.7		1.7	9.0	(1)	<1	No	(b)
Iron	1 / 1	253		253		253	1000	(1)	<1	No	(b)
Lead	1 / 1	0.52		0.52		0.52	2.5	(1)	<1	No	(b)
Magnesium	1 / 1	1170		1170		1170	NA		NA	No	(d)
Manganese	1 / 1	444		444		444	120	(6)	3.7	**Yes**	(a)
Molybdenum	0 / 1	20.0		--		20.0	370	(6)	<1	No	(b)
Nickel	1 / 1	1.8		1.8		1.8	52	(1)	<1	No	(b)
Potassium	1 / 1	1780		1780		1780	NA		NA	No	(d)
Selenium	0 / 1	1.0		--		1.0	5.0	(1)	<1	No	(b)
Silver	1 / 1	46.2		46.2		46.2	0.32	(1)	144	**Yes**	(a)
Sodium	1 / 1	1310		1310		1310	NA		NA	No	(d)
Strontium	1 / 1	35.0		35.0		35	1500	(6)	<1	No	(b)
Thallium	0 / 1	0.10		--		0.10	40	(5)	<1	No	(b)
Vanadium	0 / 1	10.0		--		10.0	12	(4)	<1	No	(b)
Zinc	1 / 1	7.2		7.2		7.2	120	(1)	<1	No	(b)

ug/L = micrograms per liter

COPEC - Chemical of Potential Ecological Concern

Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.15
Selection of Surface Water COPECs for Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Aluminum	2 / 8	5.5		41.0	J	41.0	87	(1)	<1	No	(b)
Antimony	0 / 8	50.0		--		50.0	80	(4)	<1	No	(b)
Arsenic	0 / 8	200		--		200	150	(1)	1.3	**Yes**	(a)
Barium	2 / 8	10.4		19.0		19.0	220	(4)	<1	No	(b)
Beryllium	0 / 9	10.0		--		10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	1 / 10	0.19		0.19		0.19	0.25	(1)	<1	No	(b)
Calcium	10 / 10	5700		9880		9880	NA		NA	No	(d)
Chromium	1 / 10	0.19	J	0.19	J	0.19	11	(1)	<1	No	(b)
Cobalt	4 / 10	0.27	J	1.7		1.7	24	(4)	<1	No	(b)
Copper	8 / 10	3.7		64.0		64.0	9.0	(1)	7.1	**Yes**	(a)
Iron	10 / 10	83.0		330		330	1000	(1)	<1	No	(b)
Lead	2 / 10	0.07	J	0.46		0.46	2.5	(1)	<1	No	(b)
Magnesium	10 / 10	820		1400		1400	NA		NA	No	(d)
Manganese	10 / 10	31.0		212		212	120	(6)	1.8	**Yes**	(a)
Molybdenum	0 / 4	20.0		--		20.0	370	(6)	<1	No	(b)
Nickel	4 / 10	0.43	J	5.3		5.3	52	(1)	<1	No	(b)
Potassium	8 / 8	1300		2150		2150	NA		NA	No	(d)
Selenium	0 / 10	45.0		--		45.0	5.0	(1)	9.0	**Yes**	(a)
Silver	0 / 10	218		--		218	0.32	(1)	682	**Yes**	(a)
Sodium	8 / 8	890		1320		1320	NA		NA	No	(d)
Strontium	2 / 2	35.0		39.0		39.0	1500	(6)	<1	No	(b)
Thallium	0 / 10	45.0		--		45.0	40	(5)	1.1	**Yes**	(a)
Vanadium	1 / 10	0.24	J	0.24	J	0.24	12	(4)	<1	No	(b)
Zinc	8 / 10	6.8		186		186	120	(1)	1.5	**Yes**	(a)

ug/L = microgram per liter
COPEC - Chemical of Potential Ecological Concern
* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.16
Selection of Surface Water COPECs for Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)											
Aluminum	1 / 4	10.1		10.1		10.1	87	(1)	<1	No	(b)
Antimony	0 / 4	50.0		--		50.0	80	(4)	<1	No	(b)
Arsenic	0 / 4	200		--		200	150	(1)	1.3	**Yes**	(a)
Barium	1 / 4	14.0		14.0		14.0	220	(4)	<1	No	(b)
Beryllium	0 / 4	10.0		--		10.0	3.6	(4)	2.8	**Yes**	(a)
Cadmium	1 / 4	1.9		1.9		1.9	0.25	(1)	7.7	**Yes**	(a)
Calcium	4 / 4	7500		13000		13000	NA		NA	No	(d)
Chromium	0 / 4	70.6		--		70.6	11	(1)	6.4	**Yes**	(a)
Cobalt	1 / 4	24.0		24.0		24.0	24	(4)	1.0	**Yes**	(b)
Copper	4 / 4	240		670		670	9.0	(1)	74.4	**Yes**	(a)
Iron	0 / 4	50.0		--		50.0	1000	(1)	<1	No	(b)
Lead	0 / 4	149		--		149	2.5	(1)	59.4	**Yes**	(a)
Magnesium	4 / 4	1300		2440		2440	NA		NA	No	(d)
Manganese	4 / 4	90.0		425		425	120	(6)	3.5	**Yes**	(a)
Molybdenum	0 / 1	20.0		--		20.0	370	(6)	<1	No	(b)
Nickel	1 / 4	15.9		15.9		15.9	52	(1)	<1	No	(b)
Potassium	4 / 4	1500		2130		2130	NA		NA	No	(d)
Selenium	0 / 4	22.0		--		22.0	5.0	(1)	4.4	**Yes**	(a)
Silver	0 / 4	127		--		127.3	0.32	(1)	397.9	**Yes**	(a)
Sodium	4 / 4	980		1410		1410	NA		NA	No	(d)
Strontium	1 / 1	44.0		44.0		44.0	1500	(6)	<1	No	(b)
Thallium	0 / 4	45.0		--		45.0	40	(5)	1.1	**Yes**	(a)
Vanadium	0 / 4	11.0		--		11.0	12	(4)	<1	No	(b)
Zinc	4 / 4	224		376		376	120	(1)	3.1	**Yes**	(a)

ug/L - micrograms per liter
COPEC - Chemical of Potential Ecological Concern
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
(a) The maximum concentration exceeded its benchmark
(b) The maximum concentration did not exceed its benchmark
(c) No benchmark was available
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001)

Attachment 4.17
Selection Surface Water COPECs for the Main Stem of Ely Book
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)													
Aluminum	34 / 34	100%	22.0		34000		EB-465M	34000	87	(1)	391	**Yes**	(a)
Antimony	9 / 34	26%	0.02		0.28		EB-465M	0.28	80	(4)	<1	No	(b)
Arsenic	5 / 34	15%	0.08	J	1.9		EB-465M	1.9	150	(1)	<1	No	(b)
Barium	34 / 34	100%	6.4		40.0		EB-15M	40.0	220	(4)	<1	No	(b)
Beryllium	27 / 34	79%	0.05		1.8		EB-465M	1.8	3.6	(4)	<1	No	(b)
Cadmium	33 / 34	97%	0.09		8.7		EB-15M	8.7	0.25	(1)	35	**Yes**	(a)
Calcium	35 / 35	100%	7600		65000		EB-465M	65000	NA		NA	No	(d)
Chromium	30 / 35	86%	0.11	J	15.1		EB-465M	15.1	11	(1)	1	**Yes**	(a)
Cobalt	35 / 35	100%	1.7		664		EB-465M	664	24	(4)	28	**Yes**	(a)
Copper	35 / 35	100%	12.6		6628		EB-15M	6628	9.0	(1)	736	**Yes**	(a)
Iron	32 / 35	91%	42.0		74600		EB-465M	74600	1000	(1)	75	**Yes**	(a)
Lead	21 / 33	64%	0.10		1.2		EB-90M	1.2	2.5	(1)	<1	No	(b)
Magnesium	35 / 35	100%	1000		30000		EB-465M	30000	NA		NA	No	(d)
Manganese	35 / 35	100%	20.0		3100		EB-465M	3100	120	(6)	26	**Yes**	(a)
Mercury	1 / 18	--	0.16		0.16		EB-90M	0.16	0.77	(1)	<1	No	(b)
Molybdenum	16 / 31	52%	0.03		1.8		EB-465M	1.8	370	(6)	<1	No	(b)
Nickel	35 / 35	100%	0.72		67.9		EB-465M	67.9	52	(1)	1	**Yes**	(a)
Potassium	33 / 33	100%	1300	J	5920	J	EB-515M	5920	NA		NA	No	(d)
Selenium	17 / 35	49%	0.20		1.0		EB-440M	1.0	5.0	(1)	<1	No	(b)
Silver	7 / 35	20%	0.004		0.69		EB-465M	0.69	0.32	(1)	2	**Yes**	(a)
Sodium	32 / 32	100%	720	J	11800		EB-15M	11800	NA		NA	No	(d)
Strontium	30 / 30	100%	30.0		177		EB-465M	177	1500	(6)	<1	No	(b)
Thallium	8 / 35	23%	0.04	J	0.11		EB-465M	0.11	40	(5)	<1	No	(b)
Vanadium	17 / 35	49%	0.06	J	3.0		EB-465M	3.0	12	(4)	<1	No	(b)
Zinc	34 / 34	100%	16.9		1213		EB-465M	1213	120	(1)	10	**Yes**	(a)

ug/L - micrograms per liter

COPEC - Chemical of Potential Ecological Concern

Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

J - estimated value

(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

Attachment 4.18
Selection of Surface Water COPECs for School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)													
Aluminum	36 / 36	100%	4.6		180		SB-3250M	180	87	(1)	2.1	**Yes**	(a)
Antimony	11 / 36	31%	0.02		1.7		SB-540M	1.7	80	(4)	<1	No	(b)
Arsenic	3 / 36	8%	0.09	J	0.11	J	SB-3250M	0.11	150	(1)	<1	No	(b)
Barium	36 / 36	100%	9.1		325		SB-1140M	325	220	(4)	1.5	**Yes**	(a)
Beryllium	0 / 36	*0%*	10.0		--			10.0	3.6	(4)	2.8	No	(e)
Cadmium	24 / 44	55%	0.02		0.82		SB-2940M	0.82	0.25	(1)	3.3	**Yes**	(a)
Calcium	44 / 44	100%	7000		48200		SB-2940M	48200	NA		NA	No	(d)
Chromium	9 / 44	20%	0.11	J	0.69	J	SB-3250M	0.69	11	(1)	<1	No	(b)
Cobalt	40 / 44	91%	0.03		16.0		SB-2940M	16.0	24	(4)	<1	No	(b)
Copper	43 / 44	98%	5.68		203		SB-2940M	203	9.0	(1)	22.5	**Yes**	(a)
Iron	41 / 44	93%	13.0		210		SB-3250M	210	1000	(1)	<1	No	(b)
Lead	7 / 42	17%	0.07		1.3		SB-20M	1.3	2.5	(1)	<1	No	(b)
Magnesium	44 / 44	100%	740		2700		SB-2940M	2700	NA		NA	No	(d)
Manganese	44 / 44	100%	1.1		62.0		SB-2940M	62.0	120	(6)	<1	No	(b)
Mercury	3 / 20	--	0.10		0.17		SB-3100M	0.17	0.77	(1)	<1	No	(b)
Molybdenum	16 / 37	43%	0.05		0.40		SB-540M	0.40	370	(6)	<1	No	(b)
Nickel	39 / 44	89%	0.19		4.4		SB-2940M	4.4	52	(1)	<1	No	(b)
Potassium	35 / 37	95%	630		3800		SB-2940M	3800	NA		NA	No	(d)
Selenium	7 / 45	16%	0.20		0.50		SB-2940M SB-3125M	0.50	5.0	(1)	<1	No	(b)
Silver	2 / 43	*4.7%*	0.01		0.04		SB-540M	0.04	0.32	(1)	<1	No	(b), (e)
Sodium	32 / 32	100%	970		12000		SB-540M	12000	NA		NA	No	(d)
Strontium	29 / 29	100%	49.0		277		SB-2940M	277	1500	(6)	<1	No	(b)
Thallium	0 / 44	*0%*	25.0		--			25.0	40	(5)	<1	No	(b), (e)
Vanadium	12 / 44	27%	0.10	J	0.30		SB-540M	0.30	12	(4)	<1	No	(b)
Zinc	38 / 38	100%	0.95		211		SB-2940M	211	120	(1)	1.8	**Yes**	(a)

COPEC - Chemical of Potential Ecological Concern
ug/L - micrograms per liter
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.
J - estimated value
* - If sample was not detected, value represents the maximum non-detect reporting limit (RL)
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).
(e) The compound is present above its RL in less than 5% of the samples and the number of samples collected exceeds 20.

Attachment 4.19
Selection of Surface Water COPECs for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	Benchmark	Benchmark Source	Hazard Quotient	COPEC?	Reason Code
Metals, Dissolved (ug/L)													
Aluminum	26 / 29	90%	5.7		122	J	OR-11850M	122	87	(1)	1.4	**Yes**	(a)
Antimony	10 / 29	34%	0.03		3.0		OR-22450M	3.0	80	(4)	<1	No	(b)
Arsenic	2 / 29	7%	0.29		0.30		OR-15000M	0.30	150	(1)	<1	No	(b)
Barium	29 / 29	100%	9.2		374		OR-8350M	374	220	(4)	1.7	**Yes**	(a)
Beryllium	1 / 29	3%	1.2	J	1.2	J	OR-11850M	1.2	3.6	(4)	<1	No	(b),(e)
Cadmium	9 / 29	31%	0.02		0.13		OR-22450M	0.13	0.25	(1)	<1	No	(b)
Calcium	29 / 29	100%	7900		39600		OR-22450M	39600	NA		NA	No	(d)
Chromium	7 / 29	24%	0.16	J	5.6	J	OR-11850M	5.6	11	(1)	<1	No	(b)
Cobalt	16 / 29	55%	0.03	J	1.7		OR-22450M	1.7	24	(4)	<1	No	(b)
Copper	28 / 29	97%	0.33	J	76.3		OR-22450M	76.3	9.0	(1)	8.5	**Yes**	(a)
Iron	26 / 29	90%	21.0		554		OR-8350M	554	1000	(1)	<1	No	(b)
Lead	8 / 29	28%	0.07		3.6	J	OR-11850M	3.6	2.5	(1)	1.4	**Yes**	(a)
Magnesium	29 / 29	100%	650		2400		OR-15000M	2400	NA		NA	No	(d)
Manganese	29 / 29	100%	4.4		160		OR-19150M	160	120	(6)	1.3	**Yes**	(a)
Mercury	3 / 15	20%	0.12	J	0.16		OR-11800M	0.16	0.77	(1)	<1	No	(b)
Molybdenum	14 / 18	78%	0.05		20.0		OR-22450M	20.0	370	(6)	<1	No	(b)
Nickel	15 / 29	52%	0.20		10.4		OR-22450M	10.4	52	(1)	<1	No	(b)
Potassium	29 / 29	100%	600		3300		OR-15000M	3300	NA		NA	No	(d)
Selenium	2 / 27	7%	0.20	J	3.6	J	OR-11850M	3.6	5.0	(1)	<1	No	(b)
Silver	4 / 29	14%	0.03		0.43	J	OR-8350M	0.43	0.32	(1)	1.4	**Yes**	(a)
Sodium	26 / 26	100%	2400		13700		OR-15000M	13700	NA		NA	No	(d)
Strontium	18 / 18	100%	53.0		230		OR-15000M	230	1500	(6)	<1	No	(b)
Thallium	2 / 29	7%	0.09		5.0	J	OR-11850M	5.0	40	(5)	<1	No	(b)
Vanadium	8 / 29	28%	0.13	J	0.44		OR-22450M	0.44	12	(4)	<1	No	(b)
Zinc	29 / 29	100%	0.94		9100		OR-15000M	9100	120	(1)	76	**Yes**	(a)

ug/L - microgram per liter
COPEC - Chemical of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
Note: The data for the six hardness-dependent metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) where normalized to 100 ug/L hardness for comparison to their benchmarks (normalized to 100 ug/L hardness in EPA, 2006).

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The maximum concentration exceeded its benchmark.
(b) The maximum concentration did not exceed its benchmark.
(c) No benchmark was available.
(d) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).
(e) The compound is present above its RL in less than 5% of the samples and the number of samples collected exceeds 20.

Attachment 4.20
Summary of Surface Water COPECs for Aquatic Receptors
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	Ponds						
COPEC	**2**	**3**	**4**	**5**	**Ely Brook**	**School House Brook**	**The EBOR**
Aluminum					√	√	√
Arsenic		√	√	√			
Barium						√	√
Beryllium	√	√	√	√			
Cadmium		√		√	√	√	
Chromium		√		√	√		
Cobalt				√	√		
Copper	√		√	√	√	√	√
Iron					√		
Lead				√			√
Manganese	√	√	√	√	√		√
Nickel					√		
Selenium			√	√			
Silver	√	√	√	√	√		√
Thallium			√	√			
Zinc	√		√	√	√	√	√

√ - Chemical was selected as a COPEC

Attachment 4.21
Selection of Brook Trout COPECs for School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals (mg/kg, wwt)								
Aluminium	1 / 1	12.4		12.4		SB-3125M	**Yes**	(a)
Antimony	0 / 1	0.10		--		--	No	(b)
Arsenic	0 / 1	0.30		--		--	No	(b)
Barium	1 / 1	0.30		0.30		SB-3125M	**Yes**	(a)
Beryllium	0 / 1	0.01		--		--	**Yes**	(d)
Cadmium	1 / 1	0.02		0.02		SB-3125M	**Yes**	(a)
Chromium	1 / 1	0.30		0.30		SB-3125M	**Yes**	(a)
Cobalt	1 / 1	0.10		0.10		SB-3125M	**Yes**	(a)
Copper	1 / 1	7.9		7.9		SB-3125M	**Yes**	(a)
Iron	1 / 1	46.9		46.9		SB-3125M	**Yes**	(a)
Lead	1 / 1	0.02		0.02		SB-3125M	**Yes**	(a)
Manganese	1 / 1	2.9		2.9		SB-3125M	**Yes**	(a)
Mercury	1 / 1	0.003		0.003		SB-3125M	**Yes**	(a)
Molybdenum	0 / 1	0.30		--		--	**Yes**	(d)
Nickel	0 / 1	0.10		--		--	No	(b)
Selenium	1 / 1	0.30		0.30		SB-3125M	**Yes**	(a)
Thallium	0 / 1	0.03		--		--	**Yes**	(d)
Vanadium	0 / 1	0.20		--		--	**Yes**	(c)
Zinc	1 / 1	18.8		18.8		SB-3125M	**Yes**	(a)

mg/kg, wwt - milligram per kilogram, wet weight

Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.

Note 2: See Section 4.4.1 for the fish COPEC selection process.

COPEC - Chemical of Potential Ecological Concern

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

(a) Analyte was present above its detection limit in at least one of the fish samples.

(b) Analyte was not present above its detection limit in all of the fish samples and the maximum non-detect RL was less than the No Effect CBR value.

(c) Analyte was not present above its detection limit in all of the fish samples, but the maximum non-detect RL exceeded the No Effect CBR value.

(d) Analyte was not present above its detection limit in all of the fish samples but no No Effect CBR value was available.

Attachment 4.22
Selection of Blacknose Dace COPECs for School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals (mg/kg, wwt)								
Aluminium	8 / 8	1.3		11.5		SB-140M	**Yes**	(a)
Antimony	4 / 8	0.10		0.40		SB-1360M	**Yes**	(a)
Arsenic	0 / 8	0.30		--			No	(b)
Barium	8 / 8	1.4		2.3		SB-3125M	**Yes**	(a)
Beryllium	0 / 8	0.01		--			**Yes**	(d)
Cadmium	8 / 8	0.03		0.07		SB-1360M	**Yes**	(a)
Chromium	8 / 8	0.30		0.50		SB-2400M	**Yes**	(a)
Cobalt	8 / 8	0.02		0.11		SB-140M	**Yes**	(a)
Copper	8 / 8	1.6		5.9		SB-140M	**Yes**	(a)
Iron	8 / 8	26.6		44.7		SB-140M	**Yes**	(a)
Lead	8 / 8	0.01		1.2		SB-2400M	**Yes**	(a)
Manganese	8 / 8	2.63		4.2		SB-1360M	**Yes**	(a)
Mercury	8 / 8	0.008		0.02		SB-3125M	**Yes**	(a)
Molybdenum	0 / 8	0.30		--			**Yes**	(d)
Nickel	8 / 8	0.10		0.20		SB-1360M SB-140M SB-3125M	**Yes**	(a)
Selenium	8 / 8	0.40		0.50		SB-3125M SB-2400M	**Yes**	(a)
Thallium	0 / 8	0.03		--			**Yes**	(d)
Vanadium	2 / 8	0.10		0.10		SB-1360M SB-2400M	**Yes**	(a)
Zinc	8 / 8	33.0		40.9		SB-1360M	**Yes**	(a)

mg/kg, wwt - milligrams per kilogram, wet weight

COPEC - Chemical of Potential Ecological Concern

Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.

Note 2: See Section 4.4.1 for the fish COPEC selection process.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

(a) Analyte was present above its detection limit in at least one of the fish samples.

(b) Analyte was not present above its detection limit in all of the fish samples and the maximum non-detect RL was less than the No Effect CBR value.

(c) Analyte was not present above its detection limit in all of the fish samples, but the maximum non-detect RL exceeded the No Effect CBR value.

(d) Analyte was not present above its detection limit in all of the fish samples but no No Effect CBR value was available.

Attachment 4.23
Selection of Brook Trout COPECs for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals (mg/kg, wwt)								
Aluminium	2 / 2	1.2		3.4		OR-23200M	**Yes**	(a)
Antimony	0 / 2	0.10		--			No	(b)
Arsenic	0 / 2	0.30		--			No	(b)
Barium	2 / 2	0.44		0.51		OR-23200M	**Yes**	(a)
Beryllium	0 / 2	0.01		--			**Yes**	(d)
Cadmium	2 / 2	0.01		0.03		OR-23200M	**Yes**	(a)
Chromium	1 / 2	0.30		0.30		OR-23200M	**Yes**	(a)
Cobalt	2 / 2	0.02		0.06		OR-23200M	**Yes**	(a)
Copper	2 / 2	0.80		1.3		OR-23200M	**Yes**	(a)
Iron	2 / 2	21.0		24.6		OR-23200M	**Yes**	(a)
Lead	1 / 2	0.01		0.01		OR-23200M	**Yes**	(a)
Manganese	2 / 2	2.0		3.1		OR-23200M	**Yes**	(a)
Mercury	2 / 2	0.005		0.006		OR-23200M	**Yes**	(a)
Molybdenum	0 / 2	0.30		--			**Yes**	(d)
Nickel	1 / 2	0.10		0.10		OR-23200M	**Yes**	(a)
Selenium	2 / 2	0.30		0.30		OR-23200M	**Yes**	(a)
Thallium	0 / 2	0.03		--			**Yes**	(d)
Vanadium	0 / 2	0.20		--			**Yes**	(c)
Zinc	2 / 2	16.6		18.2		OR-23200M	**Yes**	(a)

mg/kg, wwt - milligram per kilogram, wet weight
EBOR – East Branch of the Ompompanoosuc River
COPEC - Chemical of Potential Ecological Concern
Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.
Note 2: See Section 4.4.1 for the fish COPEC selection process.
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
(a) Analyte was present above its RL in at least one of the fish samples
(b) Analyte was not present above its RL in all of the fish samples and the maximum non-detect RL was less than the No Effect Critical Body Residue (CBR) value
(c) Analyte was not present above its RL in all of the fish samples, but the maximum non-detect RL exceeded the No Effect Critical Body Residue (CBR) value.
(d) Analyte was not present above its RL in all of the fish samples but no No Effect Critical Body Residue (CBR) value was available.

Attachment 4.24
Selection of Blacknose Dace COPECs for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals (mg/kg, wwt)								
Aluminum	6 / 6	3.8		16.8		OR-23630M	**Yes**	(a)
Antimony	0 / 6	0.10		--			No	(b)
Arsenic	0 / 6	0.30		--			No	(b)
Barium	6 / 6	1.4		2.4		OR-23200M	**Yes**	(a)
Beryllium	0 / 6	0.01		--			**Yes**	(d)
Cadmium	6 / 6	0.03		0.07		OR-23630M	**Yes**	(a)
Chromium	6 / 6	0.20		0.30		OR-23200M OR-23630M	**Yes**	(a)
Cobalt	6 / 6	0.06		0.09		OR-23200M	**Yes**	(a)
Copper	6 / 6	1.8		3.5		OR-23630M	**Yes**	(a)
Iron	6 / 6	28.2		50.8		OR-23630M	**Yes**	(a)
Lead	6 / 6	0.02		0.04		OR-23200M	**Yes**	(a)
Manganese	6 / 6	4.0		6.4		OR-23630M	**Yes**	(a)
Mercury	6 / 6	0.01		0.02		OR-23630M	**Yes**	(a)
Molybdenum	0 / 6	0.30		--			**Yes**	(d)
Nickel	6 / 6	0.10		0.20		OR-23200M OR-23630M	**Yes**	(a)
Selenium	6 / 6	0.30		0.50		OR-23630M	**Yes**	(a)
Thallium	0 / 6	0.03		--			**Yes**	(d)
Vanadium	0 / 6	0.20		--			**Yes**	(c)
Zinc	6 / 6	33.2		41.6		OR-23630M	**Yes**	(a)

mg/kg wwt = milligrams per kilogram, wet weight

EBOR – East Branch of the Ompompanoosuc River

COPEC - Chemical of Potential Ecological Concern

Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.

Note 2: See Section 4.4.1 for the fish COPEC selection process.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

(a) Analyte was present above its detection limit in at least one of the fish samples.

(b) Analyte was not present above its detection limit in all of the fish samples and the maximum non-detect RL was less than the No Effect Critical Body Residue (CBR) value.

(c) Analyte was not present above its detection limit in all of the fish samples, but the maximum non-detect RL exceeded the No Effect CBR value.

(d) Analyte was not present above its detection limit in all of the fish samples but no No Effect CBR value was available.

Attachment 4.25
Summary of Brook Trout and Blacknose Dace COPECs
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	School House Brook		The EBOR	
COPEC	Brook Trout	Blacknose Dace	Brook Trout	Blacknose Dace
Aluminium	√	√	√	√
Antimony		√		
Barium	√	√	√	√
Beryllium	√	√	√	√
Cadmium	√	√	√	√
Chromium	√	√	√	√
Cobalt	√	√	√	√
Copper	√	√	√	√
Iron	√	√	√	√
Lead	√	√	√	√
Manganese	√	√	√	√
Mercury	√	√	√	√
Molybdenum	√	√	√	√
Nickel		√	√	√
Selenium	√	√	√	√
Thallium	√	√	√	√
Vanadium	√	√	√	√
Zinc	√	√	√	√

√ - Chemical was selected as a COPEC

Attachment 4.26
Selection of Fish (Brook Trout and Blacknose Dace Combined) COPECs for School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals								
Aluminium	9 / 9	1.3		12.4		SB-3125M	**Yes**	(a)
Antimony	4 / 9	0.10		0.40		SB-1360M	**Yes**	(a)
Arsenic	0 / 9	0.30		--			No	(b)
Barium	9 / 9	0.30		2.3		SB-3125M	**Yes**	(a)
Beryllium	0 / 9	0.01		--			No	(b)
Cadmium	9 / 9	0.02		0.07		SB-1360M	**Yes**	(a)
Chromium	9 / 9	0.30		0.50		SB-2400M	**Yes**	(a)
Cobalt	9 / 9	0.02		0.11		SB-140M	**Yes**	(a)
Copper	9 / 9	1.6		7.9		SB-3125M	**Yes**	(a)
Iron	9 / 9	26.6		46.9		SB-3125M	**Yes**	(a)
Lead	9 / 9	0.01		1.17		SB-2400M	**Yes**	(a)
Manganese	9 / 9	2.6		4.2		SB-1360M	**Yes**	(a)
Mercury	9 / 9	0.003		0.02		SB-3125M	**Yes**	(a)
Molybdenum	0 / 9	0.30		--			No	(b)
Nickel	8 / 9	0.10		0.20		SB-1360M SB-3125M SB-140M	**Yes**	(a)
Selenium	9 / 9	0.30		0.50		SB-2400M SB-3125M	**Yes**	(a)
Thallium	0 / 9	0.03		--			No	(b)
Vanadium	2 / 9	0.10		0.10		SB-1360M SB-2400M	**Yes**	(a)
Zinc	9 / 9	18.8		40.9		SB-1360M	**Yes**	(a)

COPEC - Chemical of Potential Ecological Concern

Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.

Note 2: See Section 4.4.1 for the fish COPEC selection process.

* - If sample was not detected, value represents maximum non-detect reporting limit (RL)

(a) Analyte was present above its detection limit in at least one of the fish samples

(b) Analyte was not present above its detection limit in all of the fish samples.

Attachment 4.27
Selection of Fish (Brook Trout and Blacknose Dace Combined) COPECs for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection	Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals (mg/kg, wwt)								
Aluminium	8 / 8	1.2		16.8		OR-23630M	**Yes**	(a)
Antimony	0 / 8	0.10		--			No	(b)
Arsenic	0 / 8	0.30		--			No	(b)
Barium	8 / 8	0.44		2.4		OR-23200M	**Yes**	(a)
Beryllium	0 / 8	0.01		--			No	(b)
Cadmium	8 / 8	0.01		0.07		OR-23630M	**Yes**	(a)
Chromium	7 / 8	0.20		0.30		OR-23200M OR-23630M	**Yes**	(a)
Cobalt	8 / 8	0.02		0.09		OR-23200M	**Yes**	(a)
Copper	8 / 8	0.80		3.5		OR-23630M	**Yes**	(a)
Iron	8 / 8	21.0		50.8		OR-23630M	**Yes**	(a)
Lead	7 / 8	0.01		0.04		OR-23200M	**Yes**	(a)
Manganese	8 / 8	2.0		6.4		OR-23630M	**Yes**	(a)
Mercury	8 / 8	0.005		0.02		OR-23630M	**Yes**	(a)
Molybdenum	0 / 8	0.30		--			No	(b)
Nickel	7 / 8	0.10		0.20		OR-23200M OR-23630M	**Yes**	(a)
Selenium	8 / 8	0.30		0.50		OR-23630M	**Yes**	(a)
Thallium	0 / 8	0.03		--			No	(b)
Vanadium	0 / 8	0.20		--			No	(b)
Zinc	8 / 8	16.6		41.6		OR-23630M	**Yes**	(a)

mg/kg, wwt = milligram per kilogram, wet weight
EBOR – East Branch of the Ompompanoosuc River
COPEC - Chemical of Potential Ecological Concern
Note 1: The concentrations associated with the COPECs will be compared to fish Critical Body Residue (CBR) values.
Note 2: See Section 4.4.1 for the fish COPEC selection process.
* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
(a) Analyte was present above its detection limit in at least one of the fish samples
(b) Analyte was not present above its detection limit in all of the fish samples.

Attachment 4.28
Summary of Fish (Brook Trout and Blacknose Dace Combined) COPECs
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	School House Brook	The EBOR
Aluminium	√	√
Antimony	√	
Barium	√	√
Cadmium	√	√
Chromium	√	√
Cobalt	√	√
Copper	√	√
Iron	√	√
Lead	√	√
Manganese	√	√
Mercury	√	√
Nickel	√	√
Selenium	√	√
Vanadium	√	
Zinc	√	√

√ - Chemical was selected as a COPEC

Attachment 4.29
Selection of Surface Water COPECs for Wildlife at School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	Concentration Used for Screening	COC?	Reason Code
Metals, Total (ug/L)										
Aluminum	37 / 37	100%	39		2000		SB-2940M	2000	**Yes**	(a)
Antimony	5 / 38	13%	0.03		0.67		SB-140M	0.67	**Yes**	(a)
Arsenic	7 / 38	18%	0.09	J	0.19	J	SB-2900M	0.19	**Yes**	(a)
Barium	37 / 37	100%	9.0		30.0		SB-2940M	30.0	**Yes**	(a)
Beryllium	2 / 42	*4.8%*	0.06		0.08		SB-2940M	0.08	No	(b)
Cadmium	26 / 46	57%	0.02		1.2		SB-3245M	1.2	**Yes**	(a)
Calcium	45 / 45	100%	7300		47900		SB-2940M	47900	No	(c)
Chromium	21 / 46	46%	0.22	J	4.5	B	SB-2860M	4.5	**Yes**	(a)
Cobalt	41 / 45	91%	0.08		25.0		SB-3245M	25.0	**Yes**	(a)
Copper	45 / 45	100%	6.0		1100		SB-3245M	1100	**Yes**	(a)
Iron	45 / 45	100%	13.9	J	2200		SB-2940M	2200	**Yes**	(a)
Lead	25 / 44	57%	0.05		16.0		SB-20M	16.0	**Yes**	(a)
Magnesium	45 / 45	100%	700		2700		SB-2940M	2700	No	(c)
Manganese	45 / 45	100%	0.84	J	260		SB-3245M	260	**Yes**	(a)
Mercury	3 / 18	--	0.13	J	0.17		SB-35M	0.17	**Yes**	(a)
Molybdenum	15 / 37	41%	0.04		0.40		SB-540M	0.40	**Yes**	(a)
Nickel	41 / 46	89%	0.20		12.0		SB-540M	12.0	**Yes**	(a)
Potassium	37 / 37	100%	700		3960	J	SB-2960M	3960	No	(c)
Selenium	3 / 46	7%	0.50		8.5	J	SB-3100M	8.5	**Yes**	(a)
Silver	4 / 46	9%	0.01		0.67	J	SB-2960M	0.67	**Yes**	(a)
Sodium	34 / 34	100%	840		9900		SB-540M	9900	No	(c)
Strontium	29 / 29	100%	51.0		274		SB-2940M	274	**Yes**	(a)
Thallium	0 / 46	*0%*	25.0		--			25.0	No	(b)
Vanadium	24 / 46	52%	0.12		2.7		SB-2940M	2.7	**Yes**	(a)
Zinc	45 / 45	100%	1.7	J	150		SB-3245M	150	**Yes**	(a)
Cyanide	0 / 9	--	5.0		--			5.0	No	(d)

ug/L - micrograms per liter

COPEC - Chemical of Potential Ecological Concern

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

J - estimated value

B - analyte is associated with blank contamination

* - If sample was not detected, value represents the maximum non-detect reporting limit (RL)

(a) The compound is present above its RL in more than 5% of the samples when number of samples collected was greater than 20 or it was detected at least once when the number of samples collected was less than 20.

(b) The compound is present above its RL in less than 5% of the samples and the number of samples collected exceeds 20.

(c) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).

(d) The compound was not detected in any of the samples.

Attachment 4.30
Selection of Surface Water COPECs for Wildlife at the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

Chemicals	Frequency of Detection		Minimum Detect*	flag	Maximum Detect	flag	Maximum Location	COPEC?	Reason Code
Metals. Total (ug/L)									
Aluminum	32 / 35	91%	6.8		820		OR-22450M	**Yes**	(a)
Antimony	7 / 35	20%	0.02		0.76		OR-23630M	**Yes**	(a)
Arsenic	3 / 35	9%	0.15	J	0.20		OR-22450M	**Yes**	(a)
Barium	33 / 35	94%	10.0		30		OR-22450M	**Yes**	(a)
Beryllium	0 / 35	*0%*	10.0		--			No	(b)
Cadmium	9 / 35	26%	0.02		0.09		OR-22450M	**Yes**	(a)
Calcium	35 / 35	100%	8500		38200		OR-22450M	No	(c)
Chromium	4 / 35	11%	0.13	J	1.2		OR-22450M	**Yes**	(a)
Cobalt	18 / 35	51%	0.02		1.8		OR-22450M	**Yes**	(a)
Copper	33 / 35	94%	0.28	J	67.0		OR-22450M	**Yes**	(a)
Iron	34 / 35	97%	29.0	J	880		OR-22450M	**Yes**	(a)
Lead	14 / 35	40%	0.05		0.56		OR-15000M OR-22450M	**Yes**	(a)
Magnesium	34 / 35	97%	650		2400		OR-15000M	No	(c)
Manganese	35 / 35	100%	6.1		171		OR-19150M	**Yes**	(a)
Mercury	3 / 18	--	0.12	J	0.20		OR-22390M	**Yes**	(a)
Molybdenum	15 / 19	--	0.03		0.40		OR-15000M	**Yes**	(a)
Nickel	18 / 35	51%	0.12		10.0		OR-15000M	**Yes**	(a)
Potassium	34 / 35	97%	700		3300		OR-15000M	No	(c)
Selenium	2 / 35	6%	2.2	J	5.8	J	OR-22390M	**Yes**	(a)
Silver	1 / 35	*3%*	0.03		0.03		OR-22450M	No	(b)
Sodium	31 / 32	97%	2200		13600		OR-15000M	No	(c)
Strontium	19 / 19	--	55.0		194		OR-15000M	**Yes**	(a)
Thallium	0 / 35	*0%*	25.0		--			No	(b)
Vanadium	14 / 35	40%	0.12		0.91		OR-22450M	**Yes**	(a)
Zinc	31 / 35	89%	0.65	J	3100		OR-11850M	**Yes**	(a)
Cyanide	0 / 4	--	5.0		--			No	(d)

COPEC - Chemical of Potential Ecological Concern
EBOR – East Branch of the Ompompanoosuc River
ug/L - micrograms per liter
* - If sample was not detected, value represents maximum non-detect reporting limit (RL)
J - estimated value
(a) The compound is present above its RL in more than 5% of the samples when number of samples collected was greater than 20 or it was detected at least once when the number of samples collected was less than 20.
(b) The compound is present above its RL in less than 5% of the samples and the number of samples collected exceeds 20.
(c) The compound is a physiological electrolyte, the analyte was not selected as a COPEC (USEPA, 2001).
(d) The compound was not detected in any of the samples.

Attachment 4.31
Summary of Surface Water COPECs for Wildlife Receptors
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	School House Brook	The EBOR
Aluminum	√	√
Antimony	√	√
Arsenic	√	√
Barium	√	√
Beryllium		
Cadmium	√	√
Chromium	√	√
Cobalt	√	√
Copper	√	√
Iron	√	√
Lead	√	√
Manganese	√	√
Mercury	√	√
Molybdenum	√	√
Nickel	√	√
Selenium	√	√
Silver	√	
Strontium	√	√
Thallium		
Vanadium	√	√
Zinc	√	√
Cyanide		

√ - Chemical was selected as a COPEC

Attachment 4.32: BERA Endpoints and Weight-of-Evidence Documentation

Assessment Endpoints	Measures of effects	*Descriptive Score*[b]	*Numeric Score*[c]	Attributes[a]									
				Biological Linkage	*Correlation of Stressor/Response*	*Utility of Measure*	*Quality of Data*	*Site-Specificity*	*Sensitivity*	*Spatial representativeness*	*Temporal Representativeness*	*Quantitativeness*	*Standard Measure*
1. A stable and healthy benthic invertebrate community	1.A: Compare COPEC levels in sediment samples to conservative benchmarks	L	27	2	2	2	7	1	2	2	3	2	4
	1.B: Compare dissolved COPEC levels in pore water samples to conservative benchmarks	L	27	2	2	2	7	1	2	2	3	2	4
	1.C: Measure AVS-SEM to estimate metals bioavailability	L-M	42	4	4	4	7	4	3	2	3	4	7
	1.D: Measure toxicity in *H. azteca* and *C. tentans* exposed to pore water	M	56	5	6	6	7	5	6	4	3	6	8
	1.E: Measure toxicity in *H. azteca* and *C. tentans* exposed to bulk sediment	M-H	64	6	7	6	7	5	6	5	7	7	8
	1.F: Evaluate the structure and function of the benthic invertebrate community	H	82	10	7	9	7	10	7	8	8	8	8

Attachment 4.32: BERA Endpoints and Weight-of-Evidence Documentation

Assessment Endpoints	Measures of effects	*Descriptive Score*[b]	*Numeric Score*[c]	Attributes[a]									
				Biological Linkage	*Correlation of Stressor/Response*	*Utility of Measure*	*Quality of Data*	*Site-Specificity*	*Sensitivity*	*Spatial representativeness*	*Temporal Representativeness*	*Quantitativeness*	*Standard Measure*
2. A stable and healthy water column invertebrate community	2.A: Compare dissolved COPEC levels in surface water samples to conservative benchmarks	L	27	2	2	2	7	1	2	2	3	2	4
	2.B: Measure survival and reproduction in *C. dubia* exposed for 7 days to surface water samples	M	56	5	6	6	7	5	6	4	3	6	8
3. A stable and healthy fish community	3. A: Compare dissolved COPEC levels in surface water samples to conservative benchmarks	L	27	2	2	2	7	1	2	2	3	2	4
	3. B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed for 7 days to surface water samples	M	56	5	6	6	7	5	6	4	3	6	8
	3. C: Measure COPEC levels in whole fish for comparison to CBRs	M	57	5	4	5	6	8	5	6	8	8	5
	3. D: Evaluate the structure and function of the fish community	H	82	10	7	9	7	10	7	8	8	8	8

Attachment 4.32: BERA Endpoints and Weight-of-Evidence Documentation

Assessment Endpoints	Measures of effects	*Descriptive Score*[b]	*Numeric Score*[c]	Attributes[a]									
				Biological Linkage	*Correlation of Stressor/Response*	*Utility of Measure*	*Quality of Data*	*Site-Specificity*	*Sensitivity*	*Spatial representativeness*	*Temporal Representativeness*	*Quantitativeness*	*Standard Measure*
4. Stable and healthy amphibian populations	4.A: Compare dissolved COPEC levels in surface water samples to conservative benchmarks	L	27	2	2	2	7	1	2	2	3	2	4
	4.B: Evaluate toxicity in juvenile fathead minnows (surrogate for amphibian embryo-larvae) exposed for 7 days to surface water samples	M	53	4	6	6	7	5	4	4	3	6	8
	4.C: Evaluate *in-situ* survival and development of frog eggs and tadpoles	H	85	8	8	9	8	10	7	7	9	9	3
5. Stable and healthy insectivorous bird populations	5.A: Use food chain modeling to calculate the mean and maximum daily dose for comparison to TRVs	L-M	41	4	7	3	5	5	2	4	4	2	5
6. Stable and healthy insectivorous mammal populations	6.A: Use food chain modeling to calculate the mean and maximum daily dose for comparison to TRVs	L-M	41	4	7	3	5	5	2	4	4	2	5

Attachment 4.32: BERA Endpoints and Weight-of-Evidence Documentation

Assessment Endpoints	Measures of effects	Descriptive Score[b]	Numeric Score[c]	Attributes[a]									
				Biological Linkage	*Correlation of Stressor/Response*	*Utility of Measure*	*Quality of Data*	*Site-Specificity*	*Sensitivity*	*Spatial representativeness*	*Temporal Representativeness*	*Quantitativeness*	*Standard Measure*
7. Stable and healthy piscivorous bird populations	7.A: Use food chain modeling to calculate the mean and maximum daily dose for comparison to TRVs	M	57	7	7	6	7	7	6	4	4	2	7
8. Stable and healthy piscivorous mammal populations	8.A: Use food chain modeling to calculate the mean and maximum daily dose for comparison to TRVs	M	57	7	7	6	7	7	6	4	4	2	7

[a] The attributes are discussed in Menzie et al. (1996) who provide the following guidance for scoring:

Biological Linkage: correlation and/or applicability of the measures of effect with respect to assessment endpoint; linkage based on known biological processes; similarity of effect; target organ, mechanism of action, and level of ecological organization.
Correlation of Stressor/Response: ability of the endpoint to demonstrate effects from chronic exposure to stressor and to correlate effects with degree of exposure; susceptibility and magnitude of effects.
Utility of Measure: applicability, certainty and scientific basis of measure that is used to judge environmental harm; sensitivity of benchmark in detecting environmental harm.
Quality of Data: extent to which data quality objectives (DQOs) are met.
Site-Specificity: representativeness of chemical or biological data, environmental media, species, environmental conditions, benchmark (or reference), and habitat types that are used in the measure of effect relative to those present at the site.

Sensitivity: the percentage of the total possible variability that the endpoint is able to detect; the ability of the measure of effect to detect effects from stressor, rather than from natural or design variability or uncertainty.
Spatial Representativeness: spatial overlap of study area, measurement or sampling locations, locations of stressors, locations or receptors, and points of potential exposure to those receptors.
Temporal Representativeness: temporal overlap between the measurement period and the period during which chronic effects would likely be detected (daily, weekly, seasonally, annually).
Quantitativeness: results are quantitative/qualitative, subjective/objective, sufficient to test for statistical significance, and extent to which biological significance can be evaluated.
Standard Measure: method availability; ASTM approval, suitability and applicability to endpoint and site; need for modification of method; relationship to impact assessment, field survey, toxicity test, benchmark, toxicity quotient, or tissue residue analysis methodologies.

[b] The overall score derived for each measure of effect is a qualitative measure of its relative importance in characterizing risk at a given assessment endpoint using multiple lines of evidence. The overall score is determined by the *a priori* assignments for the 10 attributes. The scores are defined as follows: Low = 10-30; Low-Medium = 31-45; Medium = 46-60; Medium-High = 61-75; High = 76-100.

[C] The numeric scores represent the sum of all individual attribute scores for each measure of effect.

SECTION 5.0: EXPOSURE ANALYSIS

5.1 INTRODUCTION

The exposure analysis of this BERA estimated the COPEC concentrations to which each of the target receptor groups are exposed in the aquatic habitats affected by Site releases. Those aquatic habitats consisted of the following distinct EUs: (1) ponds 2 to 5 located on the east branch of Ely Brook (note: the BERA considered each of these ponds as an individual EU for baseline risk characterization, whereas the SLERA conservatively combined all of the ponds into one EU for COPEC selection), (2) the main stem of Ely Brook between where AMD first enters the stream and its confluence with Schoolhouse Brook, (3) Schoolhouse Brook below Ely Brook and the confluence with the EBOR, and (4) the EBOR below Schoolhouse Brook.

COPEC-specific EPCs were obtained for surface water, pore water, sediment, whole fish, and Estimated Daily Doses (EDDs) for wildlife receptors. The EPCs used in the risk calculations consisted of the following two values:

- A Central Tendency Exposure (CTE) was calculated by taking the arithmetic mean of the available analytical data for each COPEC identified in an EU. The CTE represented an “average” exposure experienced by the target receptors feeding or living in an EU.

- A Reasonable Maximum Exposure (RME) was calculated as the smaller of either the 95% Upper Confidence Limit (UCL) of the mean or the maximum value of the available analytical data for each COPEC identified in an EU. The RME was an “upper range” of exposure experienced by the target receptors feeding or living in an EU.

  The 95%UCL represented the highest value for a sample mean which was statistically indistinguishable from the true population mean, at a 95% confidence level (i.e., $\alpha = 0.05$). The 95% UCLs were calculated using the EPA’s ProUCL (version 4.00.02) software. ProUCL tests for normality, lognormality, and gamma distribution of a dataset, selects a conservative distribution, and computes a UCL of the unknown population mean. The Pro UCL outputs are summarized in **Appendix 14**.

EPCs were also obtained for those same COPECs at each corresponding reference location. This step was needed to calculate incremental risk by subtracting “reference” risk from “Site” risk (see Section 7.1.1.3 for more details on this topic).

5.2 CALCULATING THE EPCS FOR DIRECT EXPOSURES BY AQUATIC RECEPTORS

5.2.1 Sediment EPCs

Sediment CTE and RME EPCs (mg/kg dw) to assess risk to benthic invertebrates were obtained for the four ponds on the east branch of Ely Brook (**Attachments 5.1 to 5.4**) and pond 1, their upstream reference location (**Attachment 5.5**), the main stem of Ely Brook (**Attachment 5.6**) and its upstream reference location (**Attachment 5.7**), Schoolhouse Brook (**Attachment 5.8**) and its upstream reference location (**Attachment 5.9**), and the EBOR (**Attachment 5.10**) and its upstream reference location (**Attachment 5.11**).

5.2.2 Sediment pore water EPCs

The sediment pore water CTE and RME EPCs (µg/L) to assess risk to benthic invertebrates were obtained for the main stem of Ely Brook (**Attachment 5.12**) and its upstream reference location (**Attachment 5.13**), Schoolhouse Brook (**Attachment 5.14**) and its upstream reference location (**Attachment 5.15**), and the EBOR (**Attachment 5.16**) and its upstream reference location (**Attachment 5.17**). These values assumed that risk to benthic invertebrates exposed to metals in pore water were associated only with the dissolved (i.e., bioavailable) fraction (EPA, 2006). All of the concentrations used in calculating EPCs for the six hardness-dependent COPECs in sediment pore water were first normalized to 100 mg/L hardness for direct comparison to their corresponding surface water benchmarks.

5.2.3 Surface water EPCs

Surface water CTE and RME EPCs (µg/L) to assess risk to aquatic receptors (i.e., water column invertebrates, fish, and amphibians) were obtained for the individual ponds (**Attachments 5.18 to 5.21**) and their upstream reference pond (**Attachment 5.22**), the main stem of Ely Brook (**Attachment 5.23**) and its upstream reference location (**Attachment 5.24**), Schoolhouse Brook (**Attachment 5.25**) and its upstream reference location (**Attachment 5.26**), and the EBOR (**Attachment 5.27**) and its upstream reference location (**Attachment 5.28**). The EPCs were calculated only for the dissolved (i.e., bioavailable) fraction (EPA, 2006). All the concentrations used in calculating EPCs for the six hardness-dependent COPECs were first normalized to 100 mg/L hardness for direct comparison to their corresponding surface water benchmarks.

5.3 CALCULATING THE FISH TISSUE EPCS FOR COMPARISON TO CBRS

CTE and RME EPCs (mg/kg ww) for fish tissues were calculated for Schoolhouse Brook and the EBOR, the only two surface water bodies supporting fish. No fish were present in the ponds or the main stem of Ely Brook. The fish EPCs were separated by individual species for comparison against the CBRs.

Attachments 5.29 and 5.30 provide the EPCs for brook trout and blacknose dace in Schoolhouse Brook, whereas **Attachments 5.31 and 5.32** provide the EPCs for the same COPECs in brook trout and blacknose dace collected at the upstream reference location.

Attachments 5.33 and 5.34 provide the EPCs for brook trout and blacknose dace in the EBOR, whereas **Attachment 5.35** provides the EPCs for the same COPECs in blacknose dace collected at the upstream reference location (note: no brook trout where collected from the upstream reference location).

5.4 CALCULATING THE EPCS FOR USE IN WILDLIFE EXPOSURE MODELING

5.4.1 Surface water EPCs

Surface water CTE and RME EPCs (µg/L) to assess risk to wildlife receptors were obtained for Schoolhouse Brook (**Attachment 5.36**) and its upstream reference location (**Attachment 5.37**), and the EBOR (**Attachment 5.38**) and its upstream reference location (**Attachment 5.39**).

The CTE and RME EPCs were calculated using the total metals data since the dose for wildlife receptors drinking surface water would be associated with this fraction. The EPCs for the hardness-dependent COPECs were not adjusted for hardness since this variable would not affect the toxicity of the metals after ingestion by wildlife.

5.4.2 Fish tissue EPCs

CTE and RME EPCs (mg/kg ww) for fish tissues to assess risk to wildlife receptors were calculated for Schoolhouse Brook and the EBOR, the only two surface water bodies supporting fish. No fish were present in the ponds or the main stem of Ely Brook. The fish EPCs were combined across the two species (i.e., brook trout and blacknose dace) because of the minimal size of the brook trout samples collected from Schoolhouse Brook (n = 1) and the EBOR (n = 2)..

Attachments 5.40 provides the EPCs for brook trout and blacknose dace combined in Schoolhouse Brook, whereas **Attachments 5.41** provides the EPCs for the same COPECs in the combined fish collected from the upstream reference location. **Attachments 5.42** provides the EPCs for brook trout and blacknose dace combined in the EBOR, whereas **Attachment 5.43** provides the EPCs for the same COPECs in blacknose dace collected at the upstream reference location (note: no brook trout where collected from the upstream reference location).

5.4.3 Aquatic invertebrate EPCs

Samples of aquatic invertebrates were not collected for chemical analyses from Schoolhouse Brook or the EBOR. Yet, three of the four wildlife ROCs were assumed to feed either on aquatic life stages of benthic invertebrates (i.e., belted kingfisher) or emergent life stages of aquatic insects (i.e., tree swallow and eastern small-footed bat). The COPEC levels in invertebrates were estimated based on generic Biota-to-Sediment Accumulation Factors (BSAFs) to derive EPCs for use in wildlife food chain modeling.

BSAFs estimate how chemicals partition in organisms relative to their concentrations in co-located sediment samples. Section 3.3 in Appendix R of the Elizabeth Copper Mine BERA (URS, 2006) outlined the methods and approaches used to derive metal-specific BSAFs. **Attachment 5.44** summarizes the BSAFs used for calculating the aquatic invertebrate EPCs.

5.5 WILDLIFE FOOD CHAIN MODELING TO CALCULATE THE EDDS

Section 4 outlines the wildlife receptors evaluated in the aquatic portion of the BERA. These receptors are the tree swallow (representing insectivorous birds), the belted kingfisher (representing piscivorous birds), the eastern small-footed bat (representing insectivorous mammals and also a listed species), and the mink (representing piscivorous mammals).

5.5.1 General food web structure (based on URS, 2006)

Simplified food web models were used to calculate CTE and RME EDDs for the selected bird and mammal receptor groups by calculating exposure via ingestion of surface water and aquatic prey. The EDDs represent a dose of a COPEC that a receptor may ingest when foraging within a designated EU. The EDDs for the wildlife receptors were calculated using (1) EPCs for fish and surface water developed for each EU, (2) COPEC-specific BSAFs regression models for benthic invertebrates and emergent aquatic insects and (3) receptor-specific exposure parameters and food chain model assumptions.

The exposure routes considered by the simplified food web model for the wildlife receptors consisted of the ingestion of prey and surface water. The incidental ingestion of sediment was assumed to be negligible due to the coarse nature of the substrate in Schoolhouse Brook and the EBOR. The COPEC residues in aquatic invertebrates were estimated by multiplying the sediment concentrations by chemical-specific BSAFs. Other key exposure parameters in the model included receptor body weight, food and water ingestion rates, and an estimated area use.

The total dose (EDD_{total}) experienced by the wildlife ROCs is the sum of the doses obtained from the two primary routes of exposure, such that:

$$EDD_{total} = EDD_{diet} + EDD_{water}$$

The dose associated with each exposure route was calculated as follows:

<u>Dose from feeding on invertebrates</u>:

$$EDD_{diet} = IR_{diet} \times BSAF \times C_{substrate} \times DF_i \times AUF \times BAV/BW$$

Where:

EDD_{diet}	= Dose of COPEC from feeding on benthic or emergent invertebrates (mg COPEC/kg body weight [BW]/day)
IR_{diet}	= ingestion rate of food (kg food/day, ww [wet weight])
BSAF	= biota-sediment accumulation factor (unitless; specific to prey type and COPEC)
$C_{substrate}$	= CTE or RME COPEC level in the substrate (mg COPEC/kg substrate, dw [dry weight])
DF_i	= dietary fraction of food item I (unitless; proportion of food type in diet)
AUF	= area use factor (unitless; receptor specific)
BAV	= bioavailability adjustment factor (unitless; COPEC specific)
BW	= body weight of the receptor (kg, ww)

<u>Dose from feeding on fish</u>:

$$EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV/BW$$

Where:

EDD_{diet}	= Dose of COPEC from feeding on fish (mg COPEC/kg BW/day)
IR_{diet}	= ingestion rate of food (kg food/day, ww)
C_{fish}	= CTE or RME COPEC level in whole fish (mg COPEC/kg fish, ww)
DF_i	= dietary fraction of food item I (unitless; proportion of food type in diet)
AUF	= area use factor (unitless; receptor specific)
BAV	= bioavailability adjustment factor (unitless; COPEC specific)
BW	= body weight of the receptor (kg, ww)

<u>Dose from ingesting water</u>:

$$EDD_{water} = IR_{water} \times C_{water} \times AUF/BW$$

Where:

EDD_{water}	= Dose of COPEC obtained from surface water (mg COPEC/kg BW/day)
IR_{water}	= ingestion rate of surface water (L of water/day)
C_{water}	= CTE or RME COPEC level in surface water (mg COPEC/L water)
AUF	= area use factor (unitless; receptor specific)
BW	= body weight of the receptor (kg, ww)

5.5.2 Exposure parameters

Attachment 5.45 provides the species-specific exposure parameters used for calculating the EDDs for the four wildlife ROCs. The following assumptions were made:

- The AUF for three of the four wildlife ROCs equaled 1.0, meaning that the entire EDD was derived from within each EU (the on-site ponds, Schoolhouse Brook, and the EBOR, respectively). The tree swallow is an exception, with an assumed AUF equal to 0.75 for each EU, based on a consensus reached for the Elizabeth Copper Mine BERA (see section 3.6, Appendix R, in URS, 2006).

- None of the wildlife ROCs was exposed to COPECs via the incidental ingestion of sediment while foraging in, along, or above the water ways affected by the Site.

5.5.3 Dry weight (dw) to wet weight (ww) conversion

Sediment-to-invertebrate accumulation rates (see **Attachment 5.44**) are expressed in dw. However, the fish tissue residue data are expressed in ww. It was decided to use ww in all of the calculations to avoid confusion with the units.

The estimated food ingestion rates for the four wildlife ROCs were converted from dw (calculated using the equations developed by Nagy, 2001, see **Attachment 5.45**) to ww by assuming that fish and emergent insects have a water content equal to 80% and 75%, respectively. The average water content of whole fish was obtained from Kannan et al. (1998). The average water content of invertebrates was derived from literature data summarized in **Attachment 5.46**. This attachment shows that the average water content in aquatic invertebrates (78.3%) was higher than that in terrestrial invertebrates (68.9%). The SCM assumes that eastern small-footed bats and tree swallow feed only on emergent aquatic insects. It was therefore decided to calculate the arithmetic mean of these two values (73.6%) and round the result to 75% to obtain a reasonable estimate of the water content in recently emerged terrestrial insects.

5.5.4 Bioavailability adjustment factors

BAVs provide an estimate of the fraction of the daily intake of COPECs in prey items which is biologically available to wildlife ROCs. The derivation of BAVs is outlined in the Elizabeth Copper Mine BERA in Section 3.5 in Appendix R, Sections 1.0 and 2.0 in Appendix S, and Section 5.1.2 in the main body of the text (URS, 2006). **Attachment 5.47** summarizes these BAVs which were used in the BERA.

5.5.5 Wildlife receptor EDDs

Tree swallow

Attachment 5.48 provides the RME and CTE EDD_{total} for tree swallows feeding in Schoolhouse Brook, whereas **Attachment 5.49** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Attachment 5.50 provides the RME and CTE EDD_{total} for tree swallows feeding in the EBOR, whereas **Attachment 5.51** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Eastern small-footed bat

Attachment 5.52 provides the RME and CTE EDD_{total} for eastern small-footed bats feeding in Schoolhouse Brook, whereas **Attachment 5.53** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Attachment 5.54 provides the RME and CTE EDD_{total} for eastern small-footed bats feeding in the EBOR, whereas **Attachment 5.55** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Belted kingfisher

Attachment 5.56 provides the RME and CTE EDD_{total} for belted kingfishers feeding in Schoolhouse Brook, whereas **Attachment 5.57** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Attachment 5.58 provides the RME and CTE EDD_{total} for belted kingfishers feeding in the EBOR, whereas **Attachment 5.59** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Mink

Attachment 5.60 provides the RME and CTE EDD_{total} for mink feeding in Schoolhouse Brook, whereas **Attachment 5.61** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Attachment 5.62 provides the RME and CTE EDD_{total} for mink feeding in the EBOR, whereas **Attachment 5.63** provides the RME and CTE EDD_{total} for the same wildlife receptors feeding at the upstream reference location.

Attachment 5.1
Exposure Point Concentrations for Sediment COPECs in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)						
Barium	1 / 1	321	321	NC	321	321
Beryllium	1 / 1	1.8	1.8	NC	1.8	1.8
Cadmium	1 / 1	1.3	1.3	NC	1.3	1.3
Chromium	1 / 1	130	130	NC	130	130
Copper	1 / 1	87.6	87.6	NC	87.6	87.6
Manganese	1 / 1	769	769	NC	769	769
Molybdenum	1 / 1	2.6	2.6	NC	2.6	2.6
Nickel	1 / 1	45.4	45.4	NC	45.4	45.4
Selenium	1 / 1	1.1	1.1	NC	1.1	1.1
Silver	0 / 1	0.50	0.50	NC	0.50	0.50
Strontium	1 / 1	165	165	NC	165	165
Vanadium	1 / 1	148	148	NC	148	148
Zinc	1 / 1	131	131	NC	131	131

mg/kg, DW = milligrams per kilogram, Dry Weight

COPECs - Chemicals of Potential Ecological Concern

* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.

95% UCL - 95% Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size

Attachment 5.2
Exposure Point Concentrations for Sediment COPECs in Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration: Reasonable Maximum Exposure	Exposure Point Concentration: Central Tendency Exposure
Metals (mg/kg, DW)						
Barium	1 / 1	377	377	NC	377	377
Beryllium	1 / 1	1.6	1.6	NC	1.6	1.6
Cadmium	1 / 1	1.2	1.2	NC	1.2	1.2
Chromium	1 / 1	85.0	85.0	NC	85.0	85.0
Copper	1 / 1	81.7	81.7	NC	81.7	81.7
Lead	1 / 1	43.7	43.7	NC	43.7	43.7
Manganese	1 / 1	3130	3130	NC	3130	3130
Molybdenum	1 / 1	2.2	2.2	NC	2.2	2.2
Nickel	1 / 1	38.6	38.6	NC	38.6	38.6
Selenium	1 / 1	1.4	1.4	NC	1.4	1.4
Silver	0 / 1	0.50	0.50	NC	0.50	0.50
Strontium	1 / 1	134	134	NC	134	134
Vanadium	1 / 1	125	125	NC	125	125
Zinc	1 / 1	127	127	NC	127	127

mg/kg, DW = milligrams per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
NC - Not calculated because of small sample size

Attachment 5.3
Exposure Point Concentrations Sediment COPECs in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*		95% UCL of mean	Exposure Point Concentration: Reasonable Maximum Exposure	Exposure Point Concentration: Central Tendency Exposure
Metals (mg/kg, DW)							
Barium	2 / 2	219	337		NC	337	219
Beryllium	1 / 2	1.1	1.6		NC	1.6	1.1
Cadmium	2 / 2	1.8	2.5		NC	2.5	1.8
Chromium	2 / 2	63.5	67.0		NC	67.0	63.5
Copper	2 / 2	390	400		NC	400	390
Manganese	2 / 2	1665	2410		NC	2410	1665
Molybdenum	2 / 2	1.4	1.8		NC	1.8	1.4
Nickel	2 / 2	58.6	61.1		NC	61.1	58.6
Selenium	2 / 2	1.0	1.3	J	NC	1.3	1.0
Silver	0 / 2	0.85	1.2		NC	1.2	0.85
Strontium	1 / 1	46.0	91.9		NC	91.9	46.0
Thallium	0 / 1	0.60	1.2		NC	1.2	0.60
Vanadium	2 / 2	75.5	93.0		NC	93.0	75.5
Zinc	2 / 2	318	320	J	NC	320	318

mg/kg, DW = milligrams per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
J - estimated value
NC - Not calculated because of small sample size
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.

Attachment 5.4
Exposure Point Concentrations for Sediment COPECs in Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)						
Barium	1 / 1	296	296	NC	296	296
Beryllium	1 / 1	1.6	1.6	NC	1.6	1.6
Cadmium	1 / 1	4.0	4.0	NC	4.0	4.0
Chromium	1 / 1	70.0	70.0	NC	70.0	70.0
Cobalt	1 / 1	78.3	78.3	NC	78.3	78.3
Copper	1 / 1	3540	3540	NC	3540	3540
Manganese	1 / 1	1430	1430	NC	1430	1430
Molybdenum	1 / 1	2.5	2.5	NC	2.5	2.5
Nickel	1 / 1	56.8	56.8	NC	56.8	56.8
Selenium	1 / 1	1.3	1.3	NC	1.3	1.3
Silver	0 / 1	0.50	0.50	NC	0.50	0.50
Strontium	1 / 1	76.5	76.5	NC	76.5	76.5
Tin	1 / 1	1.6	1.6	NC	1.6	1.6
Vanadium	1 / 1	79.0	79.0	NC	79.0	79.0
Zinc	1 / 1	507	507	NC	507	507

mg/kg, DW = milligrams per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
NC - Not calculated because of small sample size

Attachment 5.5
Exposure Point Concentrations for Sediment COPECs in the Upstream Reference Pond (Pond 1)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*		95% UCL of mean	Exposure Point Concentration	
						Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Total (mg/kg, DW)							
Barium	2 / 2	175	276		NC	276	175
Beryllium	1 / 2	1.2	1.8		NC	1.8	1.2
Cadmium	1 / 2	0.98	0.80		NC	0.80	1.0
Chromium	2 / 2	71.0	102		NC	102	71.0
Cobalt	2 / 2	16.4	19.8		NC	19.8	16.4
Copper	2 / 2	65.3	86.6		NC	86.6	65.3
Lead	2 / 2	17.0	26.4		NC	26.4	17.0
Manganese	2 / 2	339	527		NC	527	339
Molybdenum	2 / 2	0.62	0.63		NC	0.63	0.62
Nickel	2 / 2	30.3	35.6		NC	35.6	30.3
Selenium	2 / 2	0.72	0.74	J	NC	0.74	0.72
Silver	0 / 2	0.83	0.58		NC	0.58	0.83
Strontium	1 / 1	86.0	172		NC	172	86.0
Tin	1 / 2	2.08	3.0		NC	3.0	2.1
Vanadium	1 / 1	81.5	163		NC	163	81.5
Zinc	2 / 2	88.0	126		NC	126	88.0

mg/kg, DW = milligrams per kilogram dry weight

Note: The metals shown in this Attachment are those identified as sediment COPECs in Ponds 2, 3, 4, and 5. Thallium was not analyzed for in Pond 1.

COPECs - Chemicals of Potential Ecological Concern

J - estimated value

* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.

95% UCL - 95% Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.6
Exposure Point Concentrations for Sediment COPECs in the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)		95% UCL of mean[1] Value	Distribution	UCL_{95} method	Exposure Point Concentration Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)									
Barium	32 / 32	66.0	236		115	NP	95% Chebyshev	115	66.0
Beryllium	7 / 32	0.62	2.0		NC	--		2.0	0.62
Cadmium	9 / 12	1.5	3.2	J	40.0	G	95% Approx Gamma	3.2	1.5
Chromium	32 / 32	32.8	83.0		NC	--		83.0	32.8
Cobalt	32 / 32	21.5	140		45.6	NP	95% Chebyshev	45.6	21.5
Copper	32 / 32	3101	6600		3873	G	95% Approx Gamma	3873	3101
Iron	32 / 32	125288	400000		141841	G	95% Approx Gamma	141841	125288
Lead	30 / 32	29.3	174		40.2	G	95% KM (BCA)	40.2	29.3
Manganese	32 / 32	298	2080		1249	NP	99% Chebyshev	1249	298
Molybdenum	30 / 30	10.9	26.0		12.7	N	95% Student's-t	12.7	10.9
Nickel	31 / 32	9.5	35.0		14.9	G	95% KM (Chebyshev)	14.9	9.5
Selenium	30 / 30	28.5	44.0		31.8	N	95% Student's-t	31.8	28.5
Silver	27 / 31	3.2	13.0	J	3.9	G	95% KM (BCA)	3.9	3.2
Strontium	6 / 6	88.0	123		NC	--		123	88.0
Thallium	7 / 26	5.3	3.3	J	NC	--		3.3	5.3
Vanadium	32 / 32	61.0	112		69.6	G	95% Approx Gamma	69.6	61.0
Zinc	32 / 32	110	410		132	LN	95% Modified-t	132	110

mg/kg, DW = milligram per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
1 - Statistics were performed using Pro UCL Software version 4.0.02
NC - Not calculated because of small sample size
Qualifier Definitions:
J - estimated value
Distribution
NC -Not Calculated because of the small number of detects
NP- non parametric
G- gamma
LN- lognormal
N- normal

Attachment 5.7
Exposure Point Concentrations for Sediment COPECs in the Upstream Reference Section of the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)								
Barium	13 / 13	106	255	159	G	95% Approx Gamma	159	106
Beryllium	3 / 13	0.74	1.6	NC	--		1.6	0.74
Cadmium	6 / 13	0.75	0.83	NC	--		0.83	0.75
Chromium	13 / 13	38.5	66.0	46.8	N	95% Student's-t	46.8	38.5
Cobalt	13 / 13	14.4	25.0	17.3	N	95% Student's-t	17.3	14.4
Copper	13 / 13	343	1230	693	G	95% Approx Gamma	693	343
Iron	12 / 12	16973	29000	21035	N	95% Student's-t	21035	16973
Lead	11 / 13	10.7	24.8	14.0	N	95% KM (t)	14.0	10.7
Manganese	13 / 13	789	2200	1667	NP	95% Chebyshev	1667	789
Molybdenum	11 / 11	0.87	3.9	2.4	NP	95% Chebyshev	2.4	0.87
Nickel	13 / 13	22.8	44.0	27.1	N	95% Student's-t	27.1	22.8
Selenium	11 / 13	2.2	4.1	2.4	G	95% KM (BCA)	2.4	2.2
Silver	0 / 13	0.96	2.1	NC	--		2.1	1.0
Strontium	3 / 3	120	133	NC	--		133	120
Thallium	0 / 10	5.8	27.5	NC	--		27.5	5.8
Vanadium	13 / 13	44.1	96.0	58.8	G	95% Approx Gamma	58.8	44.1
Zinc	12 / 13	66.8	139	85.4	G	95% KM (BCA)	85.4	66.8

Note: The metals shown in this Attachment are those identified as sediment COPECs in the main stem of Ely Brook.
mg/kg, DW = milligram per kilogram Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)
NC - Not calculated because of the small number of detects
Distribution
NP - non parametric
G - gamma
N - normal

Attachment 5.8
Exposure Point Concentrations for Sediment COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean[1]			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)								
Arsenic	31 / 34	2.0	12.0	2.8	NP	95% KM (Chebyshev)	2.8	2.0
Barium	34 / 34	62.1	199	106	NP	95% Chebyshev	106	62.1
Beryllium	7 / 34	0.56	2.0	1.6	NP	95% KM (BCA)	1.6	0.56
Chromium	34 / 34	19.8	85.0	23.3	G	95% Approx. Gamma	23.3	19.8
Cobalt	34 / 34	13.5	93.0	24.7	NP	95% Chebyshev	24.7	13.5
Copper	34 / 34	300	1390	489	NP	95% Chebyshev	489	300
Manganese	34 / 34	442	1400	655	NP	95% Chebyshev	655	442
Molybdenum	29 / 30	1.2	7.3	2.3	G	95% KM (Chebyshev)	2.3	1.2
Selenium	29 / 33	2.3	9.8	2.8	G	95% KM (BCA)	2.8	2.3
Strontium	6 / 6	194	228	212	N	95% Student's-t	212	194
Vanadium	34 / 35	23.5	62.0	34.3	NP	95% Chebyshev	34.3	23.5
Zinc	34 / 34	57.4	130 J	64.3	G	95% Approx. Gamma	64.3	57.4

mg/kg, DW - milligrams per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
J - estimated value
1- Statistics were performed using Pro UCL software version 4.0.02
Distribution
NP - non parametric
G - gamma
LN - lognormal
N - normal

Attachment 5.9
Exposure Point Concentrations for Sediment COPECs in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*		95% UCL of mean[1]			Exposure Point Concentration	
					Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, DW)									
Arsenic	8 / 12	2.2	3.0		NC	--		3.0	2.2
Barium	11 / 11	64.7	207		148	NP	95% Chebyshev	148	64.7
Beryllium	3 / 11	0.60	2.0		NC	--		2.0	0.60
Chromium	11 / 11	23.1	88.0		52.0	NP	95% Chebyshev	52.0	23.1
Cobalt	11 / 11	5.0	8.4		6.0	NP	95% Student's-t	6.0	5.0
Copper	11 / 11	10.5	24.0		14.6	G	95% Approx Gamma	14.6	10.5
Manganese	11 / 11	442	1130		599	G	95% Approx Gamma	599	442
Molybdenum	5 / 7	0.55	0.28		NC	--		0.28	0.55
Selenium	1 / 5	0.70	0.30	J	NC	--		0.30	0.70
Strontium	2 / 2	230	257		NC	--		257	230
Vanadium	11 / 11	21.5	53.0		29.7	G	95% Approx Gamma	29.7	21.5
Zinc	11 / 11	28.8	72.0	J	40.1	G	95% Gamma	40.1	28.8

Note: The metals shown in this Attachment are those identified as sediment COPECs in the impacted section of School House Brook.
mg/kg, DW - milligrams per kilogram, Dry Weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)
1 - Statistics were performed using Pro UCL Software version 4.0.02
J - estimated value
NC - Not calculated because of the small number of detects.
Distribution
NP - Non parametric
G - Gamma

Attachment 5.10
Exposure Point Concentrations for Sediment COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*		95% UCL of mean[1]			Exposure Point Concentration	
					Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Total (mg/kg, DW)									
Barium	17 / 17	46.3	195		90.0	NP	95% Chebyshev	90.0	46.3
Beryllium	4 / 17	0.40	1.8		NC	--		1.8	0.40
Copper	17 / 17	76.3	260		127	G	95% Approx. Gamma	127	76.3
Manganese	17 / 17	355	1120		475	LN	95% H-UCL	475	355
Molybdenum	8 / 10	0.92	1.1	J	NC	--		1.1	0.92
Selenium	3 / 17	1.6	0.81	J	NC	--		0.81	1.6
Silver	2 / 17	0.72	0.57	J	NC	--		0.57	0.72
Strontium	1 / 1	193	193		NC	--		193	193
Thallium	0 / 16	4.5	13.8		NC	--		13.8	4.5
Zinc	17 / 17	43.6	125		58.7	G	95% Approx. Gamma	58.7	43.6

mg/kg, DW - milligrams per kilogram, Dry Weight
EBOR – East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
*- If sample was not detected, value represents one half of the maximum non-detect Reporting Limit (RL).
95% UCL - Upper Confidence Limit of mean concentration
1 - Statistics were performed using Pro UCL Software version 4.0.02.
NC -Not Calculated because of the small number of detects or small sample size.
Qualifier Definitions:
J = estimated value
Distribution
NP - non parametric
G - gamma
LN - lognormal
N - normal

Attachment 5.11
Exposure Point Concentrations for Sediment COPECs in the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration: Reasonable Maximum Exposure	Exposure Point Concentration: Central Tendency Exposure
Metals (mg/kg, DW)						
Barium	3 / 3	79.4	187	NC	187	79.4
Beryllium	2 / 3	0.75	1.6	NC	1.6	0.75
Copper	2 / 3	3.2	4.5	NC	4.5	3.2
Manganese	3 / 3	278	475	NC	475	278
Molybdenum	1 / 1	0.16	0.16	NC	0.16	0.16
Selenium	0 / 3	1.8	5.0	NC	5.0	1.8
Silver	1 / 3	0.76	0.28 J	NC	0.28	0.76
Strontium	1 / 1	198	198	NC	198	198
Thallium	0 / 2	9.1	17.5	NC	17.5	9.1
Zinc	3 / 3	22.2	33.0	NC	33.0	22.2

Note: The metals shown in this Attachment are those identified as sediment COPECs in the impacted section of the EBOR

mg/kg, DW - milligrams per kilogram, dry weight

EBOR – East Branch of the Ompompanoosuc River

COPECs - Chemicals of Potential Ecological Concern

95% UCL - Upper Confidence Limit of mean concentration

J = estimated value

*= If sample was not detected, value represents one half of the maximum non-detect Reporting Limit (RL)

NC -Not Calculated because of the small sample size.

Attachment 5.12
Exposure Point Concentrations for Pore Water COPECs in the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Aluminum	6 / 6	95.1	456	NC	456	95.1
Arsenic	0 / 6	100	100	NC	100	100
Beryllium	0 / 6	5.0	5.0	NC	5.0	5.0
Cadmium	6 / 6	0.45	2.0	NC	2.0	0.45
Cobalt	6 / 6	32.5	95.0	NC	95.0	32.5
Copper	6 / 6	45.6	131	NC	131	45.6
Manganese	6 / 6	1782	6590	NC	6590	1782
Mercury	0 / 2	2.5	2.5	NC	2.5	2.5
Strontium	6 / 6	97.5	212	NC	212	97.5
Zinc	6 / 6	31.6	126	NC	126	31.6

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of the small sample size.
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

Attachment 5.13
Exposure Point Concentrations for Pore Water COPECs in the Upstream Reference Section of the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Aluminum	3 / 3	35.1	88.8	NC	88.8	35.1
Arsenic	0 / 3	100	100	NC	100	100
Beryllium	0 / 3	5.0	5.0	NC	5.0	5.0
Cadmium	2 / 3	2.2	0.73	NC	0.73	2.2
Cobalt	2 / 3	2.0	0.55	NC	0.55	2.0
Copper	3 / 3	3.6	6.2	NC	6.2	3.6
Manganese	3 / 3	1019	3000	NC	3000	1019
Mercury	0 / 1	2.5	2.5	NC	2.5	2.5
Strontium	3 / 3	133	258	NC	258	133
Zinc	3 / 3	5.6	12.8	NC	12.8	5.6

Note 1: the metals shown in this Attachment are those identified as pore water COPECS in the impacted section of the main stem of Ely Brook.
Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of a small sample size.
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)

Attachment 5.14
Exposure Point Concentrations for Pore Water COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of the Mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Aluminum	9 / 9	44.0	202	NC	202	44.0
Arsenic	0 / 9	100	100	NC	100	100
Beryllium	0 / 9	5.0	5.0	NC	5.0	5.0
Cadmium	9 / 9	0.11	0.30	NC	0.30	0.11
Copper	9 / 9	8.8	25.0	NC	25.0	8.8
Manganese	9 / 9	589	2030	NC	2030	589
Selenium	8 / 9	4.3	7.4	NC	7.4	4.3
Thallium	7 / 9	266	470	NC	470	266
Zinc	2 / 9	19.1	149	NC	149	19.1

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)
NC - Not calculated because of small sample size.

Attachment 5.15
Exposure Point Concentrations for Pore Water COPECs in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of the Mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Aluminum	3 / 3	40.1	98.0	NC	98.0	40.1
Arsenic	0 / 3	100	100	NC	100	100
Beryllium	0 / 3	5.0	5.0	NC	5.0	5.0
Cadmium	2 / 5	0.84	0.02	NC	0.02	0.84
Copper	2 / 5	1.9	0.58	NC	0.58	1.9
Manganese	3 / 3	1336	4000	NC	4000	1336
Selenium	0 / 3	0.50	0.50	NC	0.50	0.50
Thallium	1 / 3	0.10	0.20	NC	0.20	0.10
Zinc	3 / 5	1.4	2.2	NC	2.2	1.4

Note 1: the metals shown in this Attachment are those identified as pore water COPECS in the impacted section of School House Brook.

Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

ug/L = micrograms per liter

COPECs - Chemicals of Potential Ecological Concern

* - If sample was not detected; value represents one half of the maximum non-detect reporting limit (RL)

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of the small sample size.

Attachment 5.16
Exposure Point Concentrations for Pore Water COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	0 / 3	100	100	NC	100	100
Beryllium	0 / 3	5.0	5.0	NC	5.0	5.0
Manganese	3 / 3	1918	3700	NC	3700	1918
Mercury	0 / 1	2.5	2.5	NC	2.5	2.5

COPECs - Chemicals of Potential Ecological Concern

EBOR – East Branch of the Ompompanoosuc River

ug/L = micrograms per liter

* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.

95% UCL - Upper Confidence Limit of mean concentration

NC - Not Calculated because of the small sample size.

Attachment 5.17
Exposure Point Concentrations for Pore Water COPECs in the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	0 / 3	100	100	NC	100	100
Beryllium	0 / 3	5.0	5.0	NC	5.0	5.0
Manganese	2 / 3	2347	6830	NC	6830	2347
Mercury	0 / 1	2.5	2.5	NC	2.5	2.5

Note: the metals shown in this Attachment are those identified as pore water COPECS in the impacted section of the EBOR
COPECs - Chemicals of Potential Ecological Concern
ug/L = micrograms per liter
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)
95% UCL - Upper Confidence Limit of mean concentration
NC - Not Calculated because of the small sample size.

Attachment 5.18
Exposure Point Concentrations for Surface Water COPECs in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration: Reasonable Maximum Exposure	Exposure Point Concentration: Central Tendency Exposure
Metals, Dissolved (ug/L)						
Beryllium	0 / 6	5.0	5.0	NC	5.0	5.0
Copper	6 / 6	10.6	41.8	NC	41.8	10.6
Manganese	6 / 6	533	1400	NC	1400	533
Silver	3 / 6	6.7	0.49	NC	0.49	6.7
Zinc	6 / 6	66.8	171	NC	171	66.8

COPECs - Chemicals of Potential Ecological Concern

Note: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

ug/L = micrograms per liter

* - If sample was not detected, value represents 1/2 of the maximum non-detect reporting limit (RL).

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.19
Exposure Point Concentrations for Surface Water COPECs in Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	0 / 1	100	100	NC	100	100
Beryllium	0 / 1	5.0	5.0	NC	5.0	5.0
Cadmium	0 / 1	6.5	6.5	NC	6.5	6.5
Chromium	0 / 1	14.4	14.4	NC	14.4	14.4
Manganese	1 / 1	444	444	NC	444	444
Silver	1 / 1	46.2	46.2	NC	46.2	46.2

ug/L = micrograms per liter

COPECs - Chemicals of Potential Ecological Concern

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.20
Exposure Point Concentrations for Surface Water COPECs in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Expsoure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	0 / 8	20.8	100	NC	100	20.8
Beryllium	0 / 9	3.6	5.0	NC	5.0	3.6
Copper	8 / 10	29.6	64.0	NC	64.0	29.6
Manganese	10 / 10	98.3	212	NC	212	98.3
Selenium	0 / 10	9.1	22.5	NC	22.5	9.1
Silver	0 / 10	48.6	109	NC	109	48.6
Thallium	0 / 10	9.0	22.5	NC	22.5	9.0
Zinc	8 / 10	89.9	186	NC	186	89.9

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size or small number of detects.

Attachment 5.21
Exposure Point Concentrations for Surface Water COPECs in Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	0 / 4	33.3	100	NC	100	33.3
Beryllium	0 / 4	4.6	5.0	NC	5.0	4.6
Cadmium	1 / 4	11.1	1.9	NC	1.9	11.1
Chromium	0 / 4	26.1	35.3	NC	35.3	26.1
Cobalt	1 / 4	14.3	24	NC	24.0	14.3
Copper	4 / 4	446	670	NC	670	446
Lead	0 / 4	61.1	74.3	NC	74.3	61.1
Manganese	4 / 4	194	425	NC	425	194
Selenium	0 / 4	8.4	11	NC	11.0	8.4
Silver	0 / 4	41	63.7	NC	63.7	41.0
Thallium	0 / 4	11.1	22.5	NC	22.5	11.1
Zinc	4 / 4	318	376	NC	376	318

ug/L = micrograms per liter

COPECs - Chemicals of Potential Ecological Concern

Note: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.22
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Pond (Pond 1)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)						
Arsenic	1 / 8	20.8	0.13	NC	0.13	20.8
Beryllium	0 / 8	4.1	5.0	NC	5.0	4.1
Cadmium	0 / 8	17.0	22.9	NC	22.9	17.0
Chromium	1 / 8	38.7	0.60	NC	0.60	38.7
Cobalt	2 / 8	8.3	0.06	NC	0.06	8.3
Copper	2 / 8	39.2	4.6	NC	4.6	39.2
Lead	2 / 8	82.3	0.75	NC	0.75	82.3
Manganese	2 / 8	9.9	10.1	NC	10.1	9.9
Selenium	0 / 8	11.3	22.5	NC	22.5	11.3
Silver	0 / 8	97.8	150	NC	150	97.8
Thallium	0 / 8	11.2	22.5	NC	22.5	11.2
Zinc	5 / 8	92.8	199	NC	199	92.8

Note 1: The metals shown in this Attachment are those identified as surface water COPECs in Ponds 2, 3, 4, and 5.

Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

ug/L = micrograms per liter

COPECs - Chemicals of Potential Ecological Concern

* - Value represents the maximum non-detect reporting limit (RL), if chemical was not detected.

95% UCL - 95% Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.23
Exposure Point Concentrations for Surface Water COPECs in Ely Brook (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean[1]			Exposure Point Concentration	
				Values	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)								
Aluminum	34 / 34	5964	34000	18580	NP	99% Chebyshev	18580	5964
Cadmium	33 / 34	3.3	8.7	5.1	G	95% KM Chebyshev	3.3	5.1
Chromium	30 / 35	4.4	15.1	5.1	G	95% KM (BCA)	4.4	5.1
Cobalt	35 / 35	98.4	664	334	NP	99% Chebyshev	98.4	334
Copper	35 / 35	2532	6628	5530	NP	99% Chebyshev	2532	5530
Iron	32 / 35	9762	74600	39994	NP	99% KM Chebyshev	9762	39994
Manganese	35 / 35	562	3100	1034	LN	95% H-UCL	562	1034
Nickel	35 / 35	29.9	67.9	34.9	N	95% Student's-t	29.9	34.9
Silver	7 / 35	2.1	0.69	NC	--	--	2.1	0.69
Zinc	34 / 34	496	1213	588	N	95% Student's-t	496	588

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of the small number of detects.
Distribution
NP - non parametric
G - gamma
LN - lognormal
N - normal

Attachment 5.24
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Portion of the Main Stem of Ely Brook (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean[1]			Exposure Point Concentration	
				Values	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)								
Aluminum	9 / 10	15.2	35.0	NC	--		35.0	15.2
Cadmium	0 / 10	5.0	10.5	NC	--		10.5	5.0
Chromium	4 / 10	10.6	0.73	NC	--		0.73	10.6
Cobalt	4 / 10	2.0	0.14	NC	--		0.14	2.0
Copper	8 / 10	7.7	29.5	NC	--		29.5	7.7
Iron	8 / 10	17.9	30.0	NC	--		30.0	17.9
Manganese	10 / 10	23.6	136	175	NP	99% Chebyshev	136.0	23.6
Nickel	8 / 10	5.5	1.9	NC	--		1.9	5.5
Silver	2 / 10	5.9	0.25	NC	--		0.25	5.9
Zinc	10 / 10	50.0	137	77.6	N	95% Student's-t	77.6	50.0

Note 1: the metals shown in this Attachment are those identified as surface water COPECS in the impacted section of the main stem of Ely Brook.
Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of a small sample size or small number of detects
Distribution
NP - non parametric
N - normal

Attachment 5.25
Exposure Point Concentrations for Surface Water COPECs in School House Brook (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of the Mean[1]			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)								
Aluminum	36 / 36	87.8	180	97.3	N	95% Student's-t	97.3	87.8
Barium	36 / 36	37.9	325	87.2	NP	95% Chebyshev	87.2	37.9
Cadmium	24 / 44	0.58	0.82	0.23	G	95% KM (t)	0.23	0.58
Copper	9 / 44	74.5	203	112	G	95% KM Chebyshev	112	74.5
Zinc	35 / 37	40.8	211	69.9	LN	95% H-UCL	69.9	40.8

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
Note: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
Distribution
NP - non parametric
G - gamma
LN - lognormal
N - normal

Attachment 5.26
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Section of School House Brook (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of the Mean[1]			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)								
Aluminum	11 / 13	21.7	104	75.5	NP	97.5% KM (Chebyshev)	75.5	21.7
Barium	13 / 13	55.5	325	159	NP	95% Chebyshev	159	55.5
Cadmium	0 / 16	2.4	7.8	NC	--		7.8	2.4
Copper	7 / 16	4.7	1.2	NC	--		1.2	4.7
Zinc	12 / 13	32.4	147	86.7	G	95% KM (Chebyshev)	86.7	32.4

Note 1: the metals shown in this Attachment are those identified as surface water COPECS in the impacted section of School House Brook.

Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

ug/L = micrograms per liter

COPECs - Chemicals of Potential Ecological Concern

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)

1 - Statistics were performed using Pro UCL Software version 4.0.02

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of the small number of detects

Distribution

NP - non parametric

G - gamma

Attachment 5.27
Exposure Point Concentrations for Surface Water COPECs in the EBOR (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)		95% UCL of mean[1]			Exposure Point Concentration	
					Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)									
Aluminum	26 / 29	39.1	122	J	47.5	G	95% KM (BCA)	47.5	39.1
Barium	29 / 29	68.7	374		281.7	NP	99% Chebyshev	282	68.7
Copper	28 / 29	14.1	76.3		28.6	G	95% KM (Chebyshev)	28.6	14.1
Lead	8 / 29	20.4	3.6	J	NC	--		3.6	20.4
Manganese	29 / 29	18.1	160		40.9	NP	95% Chebyshev	40.9	18.1
Silver	4 / 29	3.1	0.43	J	NC	--		0.43	3.1
Zinc	29 / 29	809	9100		4731	NP	99% Chebyshev	4731	809

COPECs - Chemicals of Potential Ecological Concern
EBOR – East Branch of the Ompompanoosuc River
Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
ug/L = micrograms per liter
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
NC - Not Calculated because of the small number of detects
Qualifier Definitions:
J - estimated value

Distributions
NP - Non parametric
G - Gamma

Attachment 5.28
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Section of the EBOR (Aquatic Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect Concentration (qualifier)*	95% UCL of mean[1]			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Dissolved (ug/L)								
Aluminum	10 / 10	15.3	80.4 J	47.1	G	95% KM (BCA)	47.1	15.3
Barium	10 / 10	62.6	296	180	NP	95% chebyshev	180	62.6
Copper	2 / 10	4.2	0.96	NC	--		1.0	4.2
Lead	1 / 10	24.3	0.09	NC	--		0.09	24.3
Manganese	10 / 10	10.3	29.0	15.0	N	95% Student's-t	15.0	10.3
Silver	4 / 10	0.54	0.08	NC	--		0.08	0.54
Zinc	10 / 10	23	86.8	54.6	G	95% Approx Gamma	54.6	22.6

Note: the metals shown in this Attachment are those identified as surface water COPECS in the impacted section of the EBOR
COPECs - Chemicals of Potential Ecological Concern
EBOR – East Branch of the Ompompanoosuc River
ug/L = micrograms per liter
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL)
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
NC - Not Calculated because of the small number of detects
Qualifier Definitions:
J - estimated value

Attachment 5.29
Exposure Point Concentrations for Brook Trout Tissue Residues from School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	1 / 1	12.4	12.4	NC	12.4	12.4
Barium	1 / 1	0.30	0.30	NC	0.30	0.30
Beryllium	0 / 1	0.01	0.01	NC	0.01	0.01
Cadmium	1 / 1	0.02	0.02	NC	0.02	0.02
Chromium	1 / 1	0.30	0.30	NC	0.30	0.30
Cobalt	1 / 1	0.10	0.10	NC	0.10	0.10
Copper	1 / 1	7.9	7.9	NC	7.9	7.9
Iron	1 / 1	46.9	46.9	NC	46.9	46.9
Lead	1 / 1	0.02	0.02	NC	0.02	0.02
Manganese	1 / 1	2.9	2.9	NC	2.9	2.9
Mercury	1 / 1	0.003	0.003	NC	0.003	0.003
Molybdenum	0 / 1	0.15	0.15	NC	0.15	0.15
Selenium	1 / 1	0.30	0.30	NC	0.30	0.30
Thallium	0 / 1	0.02	0.02	NC	0.02	0.02
Vanadium	0 / 1	0.10	0.10	NC	0.10	0.10
Zinc	1 / 1	18.8	18.8	NC	18.8	18.8

mg/kg, wwt - milligram per kilogram, wet weight
COPECs - Chemicals of Potential Ecological Concern
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.

Attachment 5.30
Exposure Point Concentrations for Blacknose Dace Tissue Residues from School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	8 / 8	4.8	11.5	NC	11.5	4.8
Antimony	4 / 8	0.13	0.4	NC	0.40	0.13
Barium	8 / 8	2.0	2.3	NC	2.3	2.0
Beryllium	0 / 8	0.01	0.01	NC	0.01	0.01
Cadmium	8 / 8	0.04	0.07	NC	0.07	0.04
Chromium	8 / 8	0.39	0.5	NC	0.50	0.39
Cobalt	8 / 8	0.05	0.11	NC	0.11	0.05
Copper	8 / 8	4.2	5.9	NC	5.9	4.2
Iron	8 / 8	33.2	44.7	NC	44.7	33.2
Lead	8 / 8	0.16	1.17	NC	1.2	0.16
Manganese	8 / 8	3.7	4.2	NC	4.2	3.7
Mercury	8 / 8	0.01	0.02	NC	0.02	0.01
Molybdenum	0 / 8	0.15	0.15	NC	0.15	0.15
Nickel	8 / 8	0.19	0.2	NC	0.20	0.19
Selenium	8 / 8	0.43	0.5	NC	0.50	0.43
Thallium	0 / 8	0.02	0.02	NC	0.02	0.02
Vanadium	2 / 8	0.10	0.1	NC	0.10	0.10
Zinc	8 / 8	36.1	40.9	NC	40.9	36.1

mg/kg, wwt = milligram per kilogram, wet weight

COPECs - Chemicals of Potential Ecological Concern

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

95% UCL - 95% Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

Attachment 5.31
Exposure Point Concentrations for Brook Trout Tissue Residues from the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	5 / 5	4.8	6.9	NC	6.9	4.8
Barium	5 / 5	0.37	0.48	NC	0.48	0.37
Beryllium	0 / 5	0.01	0.01	NC	0.01	0.01
Cadmium	5 / 5	0.05	0.08	NC	0.08	0.05
Chromium	5 / 5	0.44	0.60	NC	0.60	0.44
Cobalt	5 / 5	0.05	0.06	NC	0.06	0.05
Copper	5 / 5	1.6	1.9	NC	1.9	1.6
Iron	5 / 5	32.9	36.0	NC	36.0	32.9
Lead	5 / 5	0.03	0.06	NC	0.06	0.03
Manganese	5 / 5	3.1	3.7	NC	3.7	3.1
Mercury	5 / 5	0.01	0.01	NC	0.01	0.01
Molybdenum	0 / 5	0.15	0.15	NC	0.15	0.15
Selenium	5 / 5	0.50	0.60	NC	0.60	0.50
Thallium	0 / 5	0.02	0.02	NC	0.02	0.02
Vanadium	2 / 5	0.12	0.20	NC	0.20	0.12
Zinc	5 / 5	21.5	23.2	NC	23.2	21.5

Note: The metals shown in this Attachment are those identified as tissue COPECs for brook trout in the impacted section of School House Brook.
mg/kg, wwt - milligram per kilogram, wet weight
COPECs - Chemicals of Potential Ecological Concern
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.

Attachment 5.32
Exposure Point Concentrations for Blacknose Dace Tissue Residues from the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	2 / 2	20.7	26.5	NC	26.5	20.7
Antimony	0 / 2	0.05	0.05	NC	0.05	0.05
Barium	2 / 2	1.1	1.1	NC	1.1	1.1
Beryllium	0 / 2	0.01	0.01	NC	0.01	0.01
Cadmium	2 / 2	0.06	0.06	NC	0.06	0.06
Chromium	2 / 2	0.50	0.50	NC	0.50	0.50
Cobalt	2 / 2	0.04	0.04	NC	0.04	0.04
Copper	2 / 2	1.0	1.0	NC	1.0	1.0
Iron	2 / 2	52.8	60.5	NC	60.5	52.8
Lead	2 / 2	0.05	0.05	NC	0.05	0.05
Manganese	2 / 2	5.7	6.1	NC	6.1	5.7
Mercury	2 / 2	0.02	0.02	NC	0.02	0.02
Molybdenum	0 / 2	0.15	0.15	NC	0.15	0.15
Nickel	2 / 2	0.20	0.20	NC	0.20	0.20
Selenium	2 / 2	0.70	0.70	NC	0.70	0.70
Thallium	0 / 2	0.02	0.02	NC	0.02	0.02
Vanadium	2 / 2	0.20	0.20	NC	0.20	0.20
Zinc	2 / 2	31.8	33.9	NC	33.9	31.8

Note: The metals shown in this Attachment are those identified as tissue COPECs for blacknose dace in the impacted section of School House Brook.
mg/kg, wwt = milligram per kilogram, wet weight
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).
COPECs - Chemicals of Potential Ecological Concern
95% UCL - 95% Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.

Attachment 5.33
Exposure Point Concentrations for Brook Trout Tissue Residues from EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration Reasonable Maximum Exposure	Exposure Point Concentration Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminum	2 / 2	2.3	3.4	NC	3.4	2.3
Barium	2 / 2	0.48	0.51	NC	0.51	0.48
Beryllium	0 / 2	0.01	0.01	NC	0.01	0.01
Cadmium	2 / 2	0.02	0.03	NC	0.03	0.02
Chromium	1 / 2	0.23	0.30	NC	0.30	0.23
Cobalt	2 / 2	0.04	0.06	NC	0.06	0.04
Copper	2 / 2	1.1	1.3	NC	1.3	1.1
Iron	2 / 2	22.8	24.6	NC	24.6	22.8
Lead	1 / 2	0.008	0.01	NC	0.01	0.01
Manganese	2 / 2	2.6	3.11	NC	3.1	2.6
Mercury	2 / 2	0.01	0.01	NC	0.01	0.01
Molybdenum	0 / 2	0.15	0.15	NC	0.15	0.15
Nickel	1 / 2	0.08	0.10	NC	0.10	0.08
Selenium	2 / 2	0.30	0.30	NC	0.30	0.30
Thallium	0 / 2	0.02	0.02	NC	0.02	0.02
Vanadium	0 / 2	0.10	0.10	NC	0.10	0.10
Zinc	2 / 2	17.4	18.2	NC	18.2	17.4

mg/kg, wwt - milligram per kilogram, wet weight
EBOR – East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
95% UCL - 95% Upper Confidence Limit of mean concentration
NC = Not calculated because of small sample size.

Attachment 5.34
Exposure Point Concentrations for Blacknose Dace Tissue Residues from EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminum	6 / 6	8.7	16.8	NC	16.8	8.7
Barium	6 / 6	2.1	2.4	NC	2.4	2.1
Beryllium	0 / 6	0.01	0.01	NC	0.01	0.01
Cadmium	6 / 6	0.05	0.07	NC	0.07	0.05
Chromium	6 / 6	0.28	0.3	NC	0.30	0.28
Cobalt	6 / 6	0.08	0.09	NC	0.09	0.08
Copper	6 / 6	2.4	3.5	NC	3.5	2.4
Iron	6 / 6	35.5	50.8	NC	50.8	35.5
Lead	6 / 6	0.03	0.04	NC	0.04	0.03
Manganese	6 / 6	5.3	6.4	NC	6.4	5.3
Mercury	6 / 6	0.02	0.02	NC	0.02	0.02
Molybdenum	0 / 6	0.15	0.15	NC	0.15	0.15
Nickel	6 / 6	0.17	0.2	NC	0.20	0.17
Selenium	6 / 6	0.38	0.5	NC	0.50	0.38
Thallium	0 / 6	0.02	0.02	NC	0.02	0.02
Vanadium	0 / 6	0.10	0.10	NC	0.10	0.10
Zinc	6 / 6	39.0	41.6	NC	41.6	39.0

mg/kg, wwt = milligrams per kilogram, wet weight

EBOR – East Branch of the Ompompanoosuc River

COPECs - Chemicals of Potential Ecological Concern

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

95% UCL - 95% Upper Confidence Limit of mean concentration

NC = Not calculated because of small sample size.

Attachment 5.35
Exposure Point Concentrations for Blacknose Dace Tissue Residues from the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration: Reasonable Maximum Exposure	Exposure Point Concentration: Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	3 / 3	6.4	8.9	NC	8.9	6.4
Barium	3 / 3	2.2	2.3	NC	2.3	2.2
Beryllium	0 / 3	0.01	0.01	NC	0.01	0.01
Cadmium	3 / 3	0.03	0.04	NC	0.04	0.03
Chromium	3 / 3	0.33	0.40	NC	0.40	0.33
Cobalt	3 / 3	0.02	0.02	NC	0.02	0.02
Copper	3 / 3	1.2	2.1	NC	2.1	1.2
Iron	3 / 3	30.9	33.5	NC	33.5	30.9
Lead	3 / 3	0.03	0.03	NC	0.03	0.03
Manganese	3 / 3	5.3	5.5	NC	5.5	5.3
Mercury	3 / 3	0.02	0.03	NC	0.03	0.02
Molybdenum	0 / 3	0.15	0.15	NC	0.15	0.15
Nickel	3 / 3	0.20	0.20	NC	0.20	0.20
Selenium	3 / 3	0.40	0.40	NC	0.40	0.40
Thallium	0 / 3	0.02	0.02	NC	0.02	0.02
Vanadium	0 / 3	0.10	0.10	NC	0.10	0.10
Zinc	3 / 3	39.0	42.5	NC	42.5	39.0

Note: The metals shown in this Attachment are those identified as tissue COPECs for blacknose dace in the impacted section of the EBOR.
mg/kg, wwt = milligrams per kilogram, wet weight
EBOR – East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
95% UCL - 95% Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.
* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

Attachment 5.36
Exposure Point Concentrations for Surface Water COPECs in School House Brook (Wildlife Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)		95% UCL of the Mean[1]			Exposure Point Concentration	
					Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, total (ug/L)									
Aluminum	37 / 37	395	2000		494	G	95% Approx Gamma	494	395
Antimony	5 / 38	13.6	0.67		NC	--		0.67	13.6
Arsenic	7 / 38	32.5	0.19	J	NC	--		0.19	32.5
Barium	37 / 37	17.4	30.0		18.8	N	95% Student's-t	18.8	17.4
Cadmium	26 / 46	0.41	1.2	B	0.23	LN	95% KM (% Bootstrap)	0.23	0.41
Chromium	21 / 46	3.0	4.5		2.0	G	95% KM (t)	2.0	3.0
Cobalt	41 / 45	4.6	25.0		6.8	NP	95% KM (Chebyshev)	6.8	4.6
Copper	45 / 45	117	1100		222	NP	95% Chebyshev	222	117
Iron	45 / 45	414	2200		569	LN	95% H-UCL	569	414
Lead	25 / 44	3.8	16.0		2.4	NP	95% KM (Chebyshev)	2.4	3.8
Manganese	45 / 45	41.5	260	J	67	NP	95% Chebyshev	67.0	41.5
Mercury	3 / 18	0.09	0.17	J	NC	--		0.17	0.09
Molybdenum	15 / 37	1.6	0.40		0.18	NP	95% KM (t)	0.18	1.6
Nickel	41 / 46	3.1	12.0		3.3	NP	95% KM (Chebyshev)	3.3	3.1
Selenium	3 / 46	1.8	8.5		NC	--		8.5	1.8
Silver	4 / 46	0.97	0.67		NC	--		0.67	0.97
Strontium	29 / 29	142	274		160	N	95% Student's-t	160	142
Vanadium	24 / 46	2.2	2.7		0.53	NP	95% KM (% Bootstrap)	0.53	2.2
Zinc	45 / 45	23.5	150		37.6	NP	95% Chebyshev	37.6	23.5

COPECs - Chemicals of Potential Ecological Concern
Note: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
ug/L = micrograms per liter
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
J - estimated value
B - analyte is associated with blank contamination
Distribution
NP - non parametric
G - gamma
LN - lognormal
N - normal

Attachment 5.37
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Section of School House Brook (Wildlife Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*		95% UCL of the Mean[1]			Exposure Point Concentration	
					Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, total (ug/L)									
Aluminum	15 / 16	183	840		599	NP	97.5% KM (chebyshev)	599	183
Antimony	2 / 16	11.3	0.10		NC	--		0.10	11.3
Arsenic	2 / 16	31.7	0.18	J	NC	--		0.18	31.7
Barium	16 / 16	16.6	28.0		19.5	N	95% Student's-t	19.5	16.6
Cadmium	3 / 18	1.1	0.02		NC	--		0.02	1.1
Chromium	6 / 18	2.7	3.0	B	NC	--		3.0	2.7
Cobalt	8 / 18	1.3	0.50		NC	--		0.50	1.3
Copper	14 / 18	1.6	2.0		1.3	N	95% KM (t)	1.3	1.6
Iron	18 / 18	163	780		726	NP	99% Chebyshev	726	163
Lead	5 / 18	6.0	0.82		NC	--		0.82	6.0
Manganese	18 / 18	16.3	80.0		28.1	LN	95% H-UCL	28.1	16.3
Mercury	0 / 7	0.07	0.10		NC	--		0.10	0.07
Molybdenum	8 / 14	1.2	0.34		NC	--		0.34	1.2
Nickel	11 / 18	1.3	1.4		0.76	N	95% KM (t)	0.76	1.3
Selenium	0 / 18	0.51	1.7		NC	--		1.7	0.51
Silver	0 / 18	0.44	2.5		NC	--		2.5	0.44
Strontium	12 / 12	139	240		169	N	95% Student's-t	169	139
Vanadium	10 / 18	0.92	1.6		0.57	LN	95% KM (% Bootstrap)	0.57	0.92
Zinc	16 / 18	7.3	49.4		24.3	LN	97.5% KM (Chebyshev)	24.3	7.3

Note 1: the metals shown in this Attachment are those identified as surface water COPECS in the impacted section of School House Brook.
Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
COPECs - Chemicals of Potential Ecological Concern
ug/L = micrograms per liter
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
1 - Statistics were performed using Pro UCL Software version 4.0.02
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of the small number of detects.
Distribution
NP - non parametric
LN - lognormal
N - normal

B - analyte is associated with blank contamination
J - estimated value

Attachment 5.38
Exposure Point Concentrations for Surface Water COPECs in the EBOR (Wildlife Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean[1] Value	95% UCL of mean[1] Distribution	95% UCL of mean[1] Method	Exposure Point Concentration Reasonable Maximum Exposure	Exposure Point Concentration Central Tendency Exposure
Metals, Total (ug/L)								
Aluminum	32 / 35	172	820	380	LN	97.5% KM (Chebyshev)	380	172
Antimony	7 / 35	10.4	0.76	NC	--		0.76	10.4
Arsenic	3 / 35	25.5	0.20	NC	--		0.20	25.5
Barium	33 / 35	19.9	30.0	19.4	G	95% KM (BCA)	19.4	19.9
Cadmium	9 / 35	0.96	0.09	NC	--		0.09	0.96
Chromium	4 / 35	3.0	1.2	NC	--		1.2	3.0
Cobalt	18 / 35	3.5	1.8	0.67	G	95% KM (BCA)	0.67	3.5
Copper	33 / 35	13.3	67	23.9	G	95% KM (Chebyshev)	23.9	13.3
Iron	34 / 35	196	880	332	LN	95% KM (Chebyshev)	332	196
Lead	14 / 35	4.5	0.56	0.43	NP	95% KM (BCA)	0.43	4.5
Manganese	35 / 35	28.8	171	34.3	LN	95% H-UCL	34.3	28.8
Mercury	3 / 18	0.10	0.20	NC	--		0.20	0.10
Molybdenum	15 / 19	1.2	0.40	0.17	G	95% KM (BCA)	0.17	1.2
Nickel	18 / 35	3.6	10	1.5	LN	95% KM (% Bootstrap)	1.5	3.6
Selenium	2 / 35	1.9	5.8 J	NC	--		5.8	1.9
Strontium	19 / 19	129	194	149	NP	95% Student's-t	149	129
Vanadium	14 / 35	3.9	0.91	NC	--		0.91	3.9
Zinc	31 / 35	93.7	3100	629	NP	97.5% KM (Chebyshev)	629	93.7

ug/L = micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
EBOR – East Branch of the Ompompanoosuc River
Note: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.
1 - Statistics were performed using Pro UCL Software version 4.0.02
COPECs - Chemicals of Potential Ecological Concern
95% UCL - Upper Confidence Limit of mean concentration
NC - Not Calculated because of small sample size.
Qualifier Definitions:
J - estimated value

Distributions
NP - Non parametric
G - Gamma
LN - Lognormal

Attachment 5.39
Exposure Point Concentrations for Surface Water COPECs in the Upstream Reference Section of the EBOR (Wildlife Receptors)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean[1]			Exposure Point Concentration	
				Value	Distribution	Method	Reasonable Maximum Exposure	Central Tendency Exposure
Metals, Total (ug/L)								
Aluminum	11 / 11	178	710	357	G	95% Approx Gamma	357	178
Antimony	5 / 11	9.4	0.07	NC	--		0.07	9.4
Arsenic	0 / 11	45.8	100	NC	--		100	45.8
Barium	11 / 11	21.3	31.0	26	G	95% Approx Gamma	26.0	21.3
Cadmium	0 / 11	2.1	2.5	NC	--		2.5	2.1
Chromium	1 / 11	3.8	1.3	NC	--		1.3	3.8
Cobalt	5 / 11	2.0	0.24	NC	--		0.24	2.0
Copper	6 / 11	2.7	1.1 J	NC	--		1.1	2.7
Iron	11 / 11	166	650	318	G	95% Approx Gamma	318	166
Lead	6 / 11	7.2	0.50	NC	--		0.50	7.2
Manganese	11 / 11	24.1	52.0	32.2	N	95% Student's-t	32.2	24.1
Mercury	0 / 2	0.05	0.05	NC	--		0.05	0.05
Molybdenum	8 / 9	1.2	0.20	NC	--		0.20	1.2
Nickel	6 / 11	1.7	0.65	NC	--		0.65	1.7
Selenium	0 / 11	0.37	1.7	NC	--		1.7	0.37
Strontium	9 / 9	133	197	NC	--		197	133
Vanadium	8 / 11	0.86	0.91	NC	--		0.91	0.86
Zinc	10 / 11	4.4	16.3	10.7	G	95% KM (Chebyshev)	10.7	4.4

Note 1: the metals shown in this Attachment are those identified as surface water COPECS in impacted reach of the EBOR.

Note 2: High analytical detection limits (which were divided in half for use in the EPC calculations) caused some of the CTEs to exceed their associated RMEs.

COPECs - Chemicals of Potential Ecological Concern

EBOR – East Branch of the Ompompanoosuc River

ug/L = micrograms per liter

1 - Statistics were performed using Pro UCL Software version 4.0.02

* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.

95% UCL - Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size

Qualifier Definitions:

J - estimated value

Distributions

Attachment 5.40
Exposure Point Concentrations for Combined Fish Tissue Residues from School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	9 / 9	5.66	12.4	NC	12.4	5.7
Antimony	4 / 9	0.12	0.40	NC	0.40	0.12
Barium	9 / 9	1.8	2.3	NC	2.3	1.8
Cadmium	9 / 9	0.04	0.07	NC	0.07	0.04
Chromium	9 / 9	0.38	0.50	NC	0.50	0.38
Cobalt	9 / 9	0.06	0.11	NC	0.11	0.06
Copper	9 / 9	4.6	7.9	NC	7.9	4.6
Iron	9 / 9	34.7	46.9	NC	46.9	34.7
Lead	9 / 9	0.15	1.17	NC	1.2	0.15
Manganese	9 / 9	3.6	4.2	NC	4.2	3.6
Mercury	9 / 9	0.01	0.02	NC	0.02	0.01
Nickel	8 / 9	0.17	0.20	NC	0.20	0.17
Selenium	9 / 9	0.41	0.50	NC	0.50	0.41
Vanadium	2 / 9	0.10	0.10	NC	0.10	0.10
Zinc	9 / 9	34.1	40.9	NC	40.9	34.1

mg/kg, wwt = milligram per kilogram, wet weight
COPECs - Chemicals of Potential Ecological Concern
95% UCL - 95% Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.

Attachment 5.41
Exposure Point Concentrations for Combined Fish Tissue Residues from the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	7 / 7	9.3	26.5	NC	26.5	9.3
Antimony	0 / 7	0.05	0.05	NC	0.05	0.05
Barium	7 / 7	0.58	1.1	NC	1.1	0.58
Cadmium	7 / 7	0.05	0.08	NC	0.08	0.05
Chromium	7 / 7	0.46	0.60	NC	0.60	0.46
Cobalt	7 / 7	0.04	0.06	NC	0.06	0.04
Copper	7 / 7	1.4	1.9	NC	1.9	1.4
Iron	7 / 7	0.01	0.02	NC	0.02	0.01
Lead	7 / 7	38.6	60.5	NC	60.5	38.6
Manganese	7 / 7	3.8	6.1	NC	6.1	3.8
Mercury	7 / 7	0.04	0.06	NC	0.06	0.04
Nickel	7 / 7	0.14	0.20	NC	0.20	0.14
Selenium	7 / 7	0.56	0.70	NC	0.70	0.56
Vanadium	4 / 7	0.14	0.20	NC	0.20	0.14
Zinc	7 / 7	24.4	33.9	NC	33.9	24.4

Note: the metals shown in this Attachment are those identified as fish COPECS in the impacted section of School House Brook. Blacknose dace and brook trout were the only fish species collected for fissue residue analysis.
mg/kg, wwt - milligram per kilogram, wet weight
COPECs - Chemicals of Potential Ecological Concern
* - Value represents one half of the maximum non-detect reporting limit (RL), if chemical was not detected.
95% UCL - Upper Confidence Limit of mean concentration
NC - Not calculated because of small sample size.

Attachment 5.42
Exposure Point Concentrations for Combined Fish Tissue Residues for the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	8 / 8	7.1	16.8	NC	16.8	7.1
Barium	8 / 8	1.7	2.4	NC	2.4	1.7
Cadmium	8 / 8	0.04	0.07	NC	0.07	0.04
Chromium	7 / 8	0.27	0.30	NC	0.30	0.27
Cobalt	8 / 8	0.07	0.09	NC	0.09	0.07
Copper	8 / 8	2.1	3.5	NC	3.5	2.1
Iron	8 / 8	32.4	50.8	NC	50.8	32.4
Lead	7 / 8	0.02	0.04	NC	0.04	0.02
Manganese	8 / 8	4.6	6.4	NC	6.4	4.6
Mercury	8 / 8	0.01	0.02	NC	0.02	0.01
Nickel	7 / 8	0.14	0.20	NC	0.20	0.14
Selenium	8 / 8	0.36	0.50	NC	0.50	0.36
Zinc	8 / 8	33.6	41.6	NC	41.6	33.6

mg/kg, wwt = milligram per kilogram, wet weight
EBOR – East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
95% UCL - 95% Upper Confidence Limit of mean concentration
NC = Not calculated because of small sample size.

Attachment 5.43
Exposure Point Concentrations for Combined Fish Tissue Residues from the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Arithmetic Mean	Maximum Detect (qualifier)*	95% UCL of mean	Exposure Point Concentration	
					Reasonable Maximum Exposure	Central Tendency Exposure
Metals (mg/kg, wwt)						
Aluminium	3 / 3	6.4	8.9	NC	8.9	6.4
Barium	3 / 3	2.2	2.3	NC	2.3	2.2
Cadmium	3 / 3	0.03	0.04	NC	0.04	0.03
Chromium	3 / 3	0.33	0.40	NC	0.40	0.33
Cobalt	3 / 3	0.02	0.02	NC	0.02	0.02
Copper	3 / 3	1.2	2.1	NC	2.1	1.2
Iron	3 / 3	0.02	33.5	NC	33.5	30.9
Lead	3 / 3	30.9	0.03	NC	0.03	0.03
Manganese	3 / 3	0.03	5.5	NC	5.5	5.28
Nickel	3 / 3	0.20	0.20	NC	0.20	0.20
Selenium	3 / 3	0.40	0.40	NC	0.40	0.40
Zinc	3 / 3	39.0	42.5	NC	42.5	39.0

Note: The metals shown in this Attachment are those identified fish COPECs in the impacted reach of the EBOR. Blacknose dace was the only fish species collected for tissue residue analyses.

mg/kg, wwt = milligrams per kilogram, wet weight

COPECs - Chemicals of Potential Ecological Concern

EBOR – East Branch of the Ompompanoosuc River

95% UCL - 95% Upper Confidence Limit of mean concentration

NC - Not calculated because of small sample size.

* - If sample was not detected, value represents one half of the maximum non-detect reporting limit (RL).

Attachment 5.44: Aquatic and emergent invertebrate BSAFs for use in food chain modeling		
COPEC	**BSAFs for the aquatic life stages of benthic invertebrates**	**BSAFs for the emergent life stages of aquatic insects**
Aluminum	0.098	0.098
Antimony	0.2	0.2
Arsenic	0.127	0.127
Barium	0.951	0.951
Beryllium	0.13	0.13
Cadmium	3.07	Regression[a]
Chromium	0.588	0.588
Cobalt	Regression[a]	Regression[a]
Copper	95%UPL[b,c]	Regression[a]
Iron	0.072	0.072
Lead	0.066	0.066
Manganese	0.505	0.505
Mercury	1.74	1.08
Molybdenum	1.15	1.15
Nickel	95%UPL[c]	95%UPL
Selenium	Regression[a]	Regression[a] * 0.4[d]
Silver	0.18	0.18
Strontium	1.0[e]	1.0[e]
Thallium	0.71	0.71
Tin	1.0[e]	1.0[e]
Vanadium	Regression[a]	Regression[a]
Zinc	95%UPL[c]	0.84
Cyanide	1.0[e]	1.0[e]

Source: Section 3.3 and Table R-3 in Appendix R of the Elizabeth Copper Mine BERA (URS, 2006).

Note: The calculated concentrations of metals in invertebrates is provided in mg/kg dry weight because the sediment concentrations are reported as mg/kg dry weight and the BSAFs are unitless.

[a] the BSAF is calculated based on the following regression models:

Metal	Model
Cadmium	y = 0.191 + 0.668 * (log[sediment])
Cobalt	y = 0.395 + 0.121 * [sediment]
Copper	y = 1.230 + 0.079 * (log[sediment])
Selenium	y = 1.422 * [sediment]
Vanadium	y = -1.531 + 0.722 * ln([sediment])

[b] 95%UPL = the 95% Upper Prediction Limit of the regression model developed for this metal

[c] See Appendix A in Bechtel Jacobs Company LLC (1998) for the procedure to calculate a 95%UPL

[d] 0.4 is a correction factor to account for the fact that around 60% of the Se is estimated to be contained in the exoskeleton which is removed in the final molt before aquatic insects emerge from the water.

[e] This BAV was not provided in Appendix R of the Elizabeth Copper Mine BERA (URS, 2006). A conservative value of 1.00 was assumed for use in the dose calculations.

Bechtel Jacobs Company LLC. 1998. Biota-sediment bioaccumulation factors for invertebrates: review and recommendations for the Oak Ridge Reservation. BJC/OR-112. Oak Ridge National Laboratory. Oak Ridge, TN.

Attachment 5.45: Summary of exposure parameters for wildlife receptors of concern evaluated in the aquatic portion of the BERA																
Representative species							**Dietary Composition**				**Ingestion Rates**					
											Food		**Water**	**Substrate**		
Common name	**Scientific name**	**Food web status**	**Home Range (km)**	**Home Range Reference**	**Area Use Factor (AUF)**	**Body Weight (kg ww)**	**Plants**	**Invertebrates**	**fish**	**reference**	**kg ww/d**	**reference**	**liters/d**	**kg ww/d**	**reference**
AVIAN RECEPTORS															
Tree swallow	*Tachycineta bicolor*	Aerial insectivore	60	Robertson et al. (1992)	0.75	0.02		100%		Sibley (2000)	0.048	Nagy (2001)	0.004	0	assumption[1]
Belted kingfisher	*Ceryle alcyon*	Aquatic piscivore	2.25	Sample & Suter (1994)	1.0	0.148		10%	90%	Sample & Suter (1994)	0.115	Nagy (2001)[2]	0.016	0	Sample & Suter (1994)
MAMMALIAN RECEPTORS															
Small-footed bat	*Myotis leibii*	Aerial insectivore	not avail.	-	1.0	0.005		100%		DeGraaf et al. (1986)	0.0044	Nagy (2001)[3]	0.001	0	assumption
Mink	*Mustela vison*	Semi-aquatic piscivore	2.63	Sample & Suter (1994)	1.0	1.0			100%	USEPA (1993); Sample & Suter, 1994	0.1995	Nagy (2001)[4]	0.099	0	Sample & Suter (1994)

Source: Table R-1 in Appendix R of URS (2006). The food ingestion rates in Table R-1 were originally presented in dry weight. These values were converted to wet weight by assuming that fish and emergent insects have a water content equal to 80% and 75%, respectively. The original food ingestion rates in Table R-1 were modified as follows: tree swallow = 0.012 kg dw/day x 4 = 0.048 kg ww/day; kingfisher = 0.023 kg dw/day X 5 = 0.115 kg ww/day; small-footed bat = 0.0011 kg dw/day X 4 = 0.0044 kg ww/day; mink = 0.0399 kg dw/day X 5 = 0.1995 kg ww/day.

Notes:
[1] assumption based on the assumption from Sample and Suter (1994) that substrate ingestion is negligible for aerial insectivores
[2] estimated food ingestion rate (kg/day dry weight) for carnivorous birds = (0.849[body weight in grams]$^{0.663}$)/1000 (Nagy, 2001)
[3] estimated food ingestion rate (kg/day dry weight) for Chiroptera = (0.365[body weight in grams]$^{0.671}$)/1000 (Nagy, 2001)
[4] estimated food ingestion rate (kg/day dry weight) for Carnivora = (0.102[body weight in grams]$^{0.864}$)/1000 (Nagy, 2001)

references:

De Graaf, R.M. and D.D. Rudis. 1986. New England wildlife: habitat, natural history, and distribution. General Technical Report NE-108. Broomall, PA: USDA, Forest Service, Northeatern Forest Experiment Station. 491 p.

Nagy, K.A. 2001. Food requirements for wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews, Series B: Lifestock Feeds and Feeding, Volume 71, No. 10.

Robertson, R.J., B.J. Stutchbury, and R.R. Cohen. 1992. Tree swallow (*Tachycineta bicolor*). The Birds of North America, No. 11 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, DC.

Sample, B.E. and G.W. Suter. 1994. Estimating exposure of terrestrial wildlife to contaminants. ES/ER/TN-125. Oak Ridge National Laboratory, Oak Ridge, TN.

Sibley, D.A. 2000. The Sibley guide to birds. New York: Alfred A. Knopf. 544 p.

U.S. EPA. 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187.

Attachment 5.46: Water content in aquatic and terrestrial invertebrates					
Common Name	**Scientific name**	**Life stage**	**Water Content (range)**	**Comment**	**Reference**
FRESWATER AQUATIC INVERTEBRATES					
caddis fly	*Limnephilus affinis*	larvae	82.5% (80%-85%)	whole organism	Sutcliffe, 1961
crayfish	*Austropotamobius pallipes*	adult	76%	whole organism	Taylor et al., 1987
freshwater crab	*Potamon niloticus*	adult(?)	79% (75%-83%)	muscle	Shaw, 1958
aquatic insect	*Corixa dentipes*	adult(?)	74.3%	whole organism	Staddon, 1964
amphipod	*Gammarus pulex*	adult male	79.8%	whole organism	Sutcliffe, 1971
average water content in freshwater aquatic invertebrates			**78.3%**		
TERRESTRIAL INVERTEBRATES					
cockroach	*Periplaneta americana*	adult; both sexes	69.5%	whole organism	Machin et al., 1991
aphid insect	*Aphis fabae*	adult	68.1% (64%-72.5%)	whole organism	Cockbain, 1961
flesh fly	*Sarcophaga crassipalpis*	adult female	67.5%	whole organism	Yoder and Delinger, 1991
tobacco hornworm	*Manduca sexta*	caterpillar	84.5%	carcass	Reynolds and Bellward, 1989
fruit fly	*Drosophila (many species)*	adult	65%	whole organism	Gibbs and Matzkin, 2001
spider beetle	*Mezium affine*	adult female	64%	whole organism	Benoit et al., 2005
scorpion	*four species*	adult	64.8% (63%-66.5%)	whole organism	Gefen and Ar, 2005
golden rod gall fly	*Eurosta Solidaginis*	larvae	60% (58%-62%)	whole organism	Williams and Lee, 2005
apterygote insect	*Thermobia domestica*	adult	75.6%	whole organism	Okasha, 1972
average water content in terrestrial invertebrates			**68.9%**		

Attachment 5.47: Bioavailability adjustment factors (BAVs) for carnivores		
COPEC	Diet	
	Birds	Mammals
Aluminum	1.00[c]	1.00[c]
Antimony	1.00	1.00
Arsenic	1.00	1.00
Barium	1.00	1.00[c]
Beryllium	1.00	1.00
Cadmium	1.00	0.54
Chromium	1.00	0.09
Cobalt	1.00	1.00
Copper	0.53	1.00
Lead	0.43	1.00
Manganese	1.00[c]	1.00[c]
Mercury (inorganic)	1.00	0.25
Mercury (organic)	1.00	1.00
Molybdenum	1.00[c]	1.00
Nickel	1.00	1.00
Selenium	0.44[a]/.40[b]	0.57[a]/0.40[b]
Silver	1.00	1.00
Thallium	1.00[c]	1.00
Vanadium	1.00[c]	1.00
Zinc	1.00	1.00
Cyanide	1.00[c]	1.00[c]

Source: Section 1.0 (Mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006).

Note 1: The BAVs for sediment were omitted from this attachment because wildlife receptors feeding on aquatic prey are assumed not to be exposed to COPECs in sediment via incidental ingestion.

[a] This BAV applies to piscivores only
[b] This BAV applies to insectivores only
[c] This BAV was not provided in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). A conservative value of 1.00 was assumed for use in the dose calculations.

Estimated Daily Doses for Tree Swallows at School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	BAV*	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD[3]	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	(BAV)*	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD[3]
Metals																
Aluminum	12000	494	0.098	1.0	1.0	2.12E+03	7.41E-02	2.12E+03	7007	395	0.098	1.0	1.0	1.24E+03	5.92E-02	1.24E+03
Antimony	2.4	0.67	0.2	1.0	1.0	8.60E-01	1.01E-04	8.61E-01	3.5	13.6	0.2	1.0	1.0	1.27E+00	2.05E-03	1.27E+00
Arsenic	2.8	0.19	0.127	1.0	1.0	6.41E-01	2.85E-05	6.41E-01	2.0	32.5	0.127	1.0	1.0	4.62E-01	4.87E-03	4.67E-01
Barium	106	18.8	0.951	1.0	1.0	1.82E+02	2.82E-03	1.82E+02	62.1	17.4	0.951	1.0	1.0	1.06E+02	2.61E-03	1.06E+02
Beryllium	1.6	0.08	0.13	1.0	1.0	3.77E-01	1.20E-05	3.77E-01	0.56	2.6	0.13	1.0	1.0	1.31E-01	3.84E-04	1.32E-01
Cadmium^	0.49	0.23	-0.02	1.0	1.0	-1.41E-02	3.41E-05	-1.40E-02	0.58	0.41	0.03	1.0	1.0	3.64E-02	6.12E-05	3.65E-02
Chromium	23.3	2.0	0.588	1.0	1.0	2.46E+01	2.98E-04	2.46E+01	19.8	3.0	0.588	1.0	1.0	2.10E+01	4.52E-04	2.10E+01
Cobalt	24.7	6.8	3.39	1.0	1.0	1.51E+02	1.01E-03	1.51E+02	13.5	4.6	2.03	1.0	1.0	4.94E+01	6.85E-04	4.94E+01
Copper	489	222	1.44	0.53	1.0	6.73E+02	3.33E-02	6.74E+02	300	117	1.43	0.53	1.0	4.08E+02	1.76E-02	4.08E+02
Iron	58800	569	0.072	1.0	1.0	7.62E+03	8.54E-02	7.62E+03	14267	414	0.072	1.0	1.0	1.85E+03	6.21E-02	1.85E+03
Lead	31.4	2.4	0.066	0.43	1.0	1.60E+00	3.60E-04	1.60E+00	7.9	3.8	0.066	0.43	1.0	4.04E-01	5.70E-04	4.05E-01
Manganese	655	67.0	0.505	1.0	1.0	5.95E+02	1.01E-02	5.95E+02	442	41.5	0.505	1.0	1.0	4.02E+02	6.22E-03	4.02E+02
Mercury	0.02	0.17	1.08	1.0	1.0	4.67E-02	2.55E-05	4.67E-02	0.03	0.09	1.08	1.0	1.0	5.57E-02	1.39E-05	5.57E-02
Molybdenum	2.3	0.18	1.15	1.0	1.0	4.70E+00	2.67E-05	4.70E+00	1.2	1.6	1.15	1.0	1.0	2.52E+00	2.43E-04	2.52E+00
Nickel	22.0	3.3	1.32	1.0	1.0	5.24E+01	5.02E-04	5.24E+01	12.9	3.1	1.42	1.0	1.0	3.30E+01	4.64E-04	3.30E+01
Selenium	2.8	8.5	1.57	0.40	1.0	3.13E+00	1.28E-03	3.13E+00	2.3	1.8	1.33	0.40	1.0	2.23E+00	2.64E-04	2.23E+00
Silver	0.49	0.67	0.18	1.0	1.0	1.59E-01	1.01E-04	1.59E-01	0.67	0.97	0.18	1.0	1.0	2.17E-01	1.46E-04	2.17E-01
Strontium	212	160	1.0	1.0	1.0	3.81E+02	2.40E-02	3.81E+02	194	142	1.0	1.0	1.0	3.50E+02	2.13E-02	3.50E+02
Vanadium	34.3	0.53	1.02	1.0	1.0	6.29E+01	8.01E-05	6.29E+01	23.5	2.2	0.75	1.0	1.0	3.16E+01	3.31E-04	3.16E+01
Zinc	64.3	37.6	0.84	1.0	1.0	9.73E+01	5.64E-03	9.73E+01	57.4	23.5	0.84	1.0	1.0	8.67E+01	3.52E-03	8.67E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
EDD - Estimated Daily Dose
DF - Dose Fraction for invertebrates
BAV - Bioavailability Adjustment Factor
BSAF - Biota-Sediment Accumulation Factor (for emergent aquatic insects)
** - Aluminum, antimony, cadmium, iron, lead, mercury, nickel, and silver were not selected as COPECs in fish. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
~ -Beryllium was not selected as COPECs in surface water. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times BSAF \times C_{sed} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 $Total\ EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 0.75
Body Weight (BW) 0.02
IR_{diet} 0.048
IR_{water} 0.004

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]^0.4
Vanadium	-1.531+ (0.722*LN[sediment])

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.49
Estimated Daily Doses for Tree Swallows in the Upstream Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	BAV*	DF	EDD_{diet} 1	EDD_{water} 2	Total EDD	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	BAV*	DF	EDD_{diet} 1	EDD_{water} 2	Total EDD
Metals																
Aluminum	12000	599	0.098	1.0	1.0	2.12E+03	8.98E-02	2.12E+03	7308	183	0.098	1.0	1.0	1.29E+03	2.74E-02	1.29E+03
Antimony	0.15	0.10	0.2	1.0	1.0	5.40E-02	1.50E-05	5.40E-02	3.2	11.3	0.2	1.0	1.0	1.15E+00	1.70E-03	1.16E+00
Arsenic	3.0	0.18	0.127	1.0	1.0	6.86E-01	2.70E-05	6.86E-01	2.2	31.7	0.127	1.0	1.0	4.92E-01	4.76E-03	4.97E-01
Barium	148	19.5	0.951	1.0	1.0	2.54E+02	2.92E-03	2.54E+02	64.7	16.6	0.951	1.0	1.0	1.11E+02	2.48E-03	1.11E+02
Beryllium	2.0	5.0	0.13	1.0	1.0	4.68E-01	7.50E-04	4.69E-01	0.60	2.8	0.13	1.0	1.0	1.41E-01	4.13E-04	1.41E-01
Cadmium	1.5	0.02	0.31	1.0	1.0	8.33E-01	3.00E-06	8.33E-01	0.57	1.1	0.03	1.0	1.0	2.89E-02	1.63E-04	2.91E-02
Chromium	52.0	3.0	0.588	1.0	1.0	5.50E+01	4.50E-04	5.50E+01	23.1	2.7	0.588	1.0	1.0	2.45E+01	4.04E-04	2.45E+01
Cobalt	6.0	0.50	1.12	1.0	1.0	1.20E+01	7.50E-05	1.20E+01	5.0	1.3	1.00	1.0	1.0	9.11E+00	1.96E-04	9.11E+00
Copper	14.6	1.3	1.32	0.53	1.0	1.84E+01	1.92E-04	1.84E+01	10.5	1.6	1.31	0.53	1.0	1.31E+01	2.34E-04	1.31E+01
Iron	25800	726	0.072	1.0	1.0	3.34E+03	1.09E-01	3.34E+03	9928	163	0.072	1.0	1.0	1.29E+03	2.44E-02	1.29E+03
Lead	11.2	0.82	0.066	0.43	1.0	5.72E-01	1.23E-04	5.72E-01	5.4	6.0	0.066	0.43	1.0	2.74E-01	8.98E-04	2.75E-01
Manganese	599	28.1	0.505	1.0	1.0	5.45E+02	4.21E-03	5.45E+02	442	16.3	0.505	1.0	1.0	4.02E+02	2.45E-03	4.02E+02
Mercury	0.01	0.10	1.08	1.0	1.0	2.72E-02	1.50E-05	2.72E-02	0.03	0.07	1.08	1.0	1.0	5.97E-02	1.07E-05	5.97E-02
Molybdenum	0.28	0.34	1.15	1.0	1.0	5.80E-01	5.10E-05	5.80E-01	0.55	1.2	1.15	1.0	1.0	1.14E+00	1.74E-04	1.14E+00
Nickel	21.0	0.76	1.33	1.0	1.0	5.04E+01	1.14E-04	5.04E+01	13.3	1.3	1.42	1.0	1.0	3.40E+01	2.02E-04	3.40E+01
Selenium	0.30	1.7	0.17	0.40	1.0	3.69E-02	2.55E-04	3.71E-02	0.70	0.51	0.40	0.40	1.0	2.01E-01	7.71E-05	2.01E-01
Silver	0.36	2.5	0.18	1.0	1.0	1.17E-01	3.75E-04	1.17E-01	0.97	0.44	0.18	1.0	1.0	3.14E-01	6.54E-05	3.14E-01
Strontium	257	169	1.0	1.0	1.0	4.63E+02	2.53E-02	4.63E+02	230	139	1.0	1.0	1.0	4.13E+02	2.08E-02	4.13E+02
Thallium	20.0	2.6	0.71	1.0	1.0	2.56E+01	3.83E-04	2.56E+01	2.8	0.58	0.71	1.0	1.0	3.54E+00	8.75E-05	3.54E+00
Vanadium	29.7	0.57	0.92	1.0	1.0	4.91E+01	8.61E-05	4.91E+01	21.5	0.92	0.68	1.0	1.0	2.64E+01	1.38E-04	2.64E+01
Zinc	40.1	24.3	0.84	1.0	1.0	6.07E+01	3.64E-03	6.07E+01	28.8	7.3	0.84	1.0	1.0	4.36E+01	1.10E-03	4.36E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction for invertebrates
BAV - Bioavailability Adjustment Factor
BSAF - Biota-Sediment Accumulation Factor (for emergent aquatic insects)
** - Aluminum, antimony, arsenic, cobalt, copper, iron, lead, nickel, and zinc were not selected as COPECs in fish. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
~ Beryllium, selenium, and thallium were not selected as COPECs in surface water. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times BSAF \times C_{sed} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 $\text{Total EDD} = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 0.75
Body Weight (BW) 0.02
IR_{diet} 0.048
IR_{water} 0.004

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+ (0.121*[sediment])
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]*0.4
Vanadium	-1.531+ (0.722*LN[sediment])

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.50
Estimated Daily Doses for Tree Swallows at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration: Sediment (mg/kg, wet weight)**	RME Exposure Point Concentration: Surface Water (ug/L)~	EDD (mg/kg bw-day) Diet: BSAF	Diet: BAV*	Diet: DF	Diet: EDD_{diet} [1]	Water: EDD_{water} [2]	Total EDD[3]	CTE Exposure Point Concentration: Sediment (mg/kg, wet weight)**	CTE Exposure Point Concentration: Surface Water (ug/L)~	EDD (mg/kg bw-day) Diet: BSAF	Diet: (BAV)*	Diet: DF	Diet: EDD_{diet} [1]	Water: EDD_{water} [2]	Total EDD[3]
Metals																
Aluminum	14000	380	0.098	1.0	1.0	2.47E+03	5.70E-02	2.47E+03	7847	172	0.098	1.0	1.0	1.38E+03	2.58E-02	1.38E+03
Antimony	1.8	0.76	0.2	1.0	1.0	6.48E-01	1.14E-04	6.48E-01	3.7	10.4	0.2	1.0	1.0	1.33E+00	1.56E-03	1.33E+00
Arsenic	5.0	0.20	0.127	1.0	1.0	1.14E+00	3.00E-05	1.14E+00	2.6	25.5	0.127	1.0	1.0	5.97E-01	3.83E-03	6.01E-01
Barium	90.0	19.4	0.951	1.0	1.0	1.54E+02	2.91E-03	1.54E+02	46.3	19.9	0.951	1.0	1.0	7.93E+01	2.98E-03	7.93E+01
Beryllium	1.8	5.0	0.13	1.0	1.0	4.21E-01	7.50E-04	4.22E-01	0.40	2.8	0.13	1.0	1.0	9.24E-02	4.16E-04	9.28E-02
Cadmium^	0.18	0.09	-0.31	1.0	1.0	-9.93E-02	1.34E-05	-9.93E-02	0.62	0.96	0.05	1.0	1.0	5.55E-02	1.44E-04	5.56E-02
Chromium	31.5	1.2	0.588	1.0	1.0	3.33E+01	1.80E-04	3.33E+01	18.9	3.0	0.588	1.0	1.0	2.00E+01	4.53E-04	2.00E+01
Cobalt	28.5	0.67	3.84	1.0	1.0	1.97E+02	1.01E-04	1.97E+02	9.3	3.5	1.52	1.0	1.0	2.56E+01	5.25E-04	2.56E+01
Copper	127	23.9	1.40	0.53	1.0	1.69E+02	3.58E-03	1.69E+02	76.3	13.3	1.38	0.53	1.0	1.00E+02	2.00E-03	1.00E+02
Iron	22800	332	0.072	1.0	1.0	2.95E+03	4.98E-02	2.95E+03	10694	196	0.072	1.0	1.0	1.39E+03	2.94E-02	1.39E+03
Lead	11.0	0.43	0.066	0.43	1.0	5.62E-01	6.44E-05	5.62E-01	6.0	4.5	0.066	0.43	1.0	3.07E-01	6.70E-04	3.07E-01
Manganese	475	34.3	0.505	1.0	1.0	4.32E+02	5.15E-03	4.32E+02	355	28.8	0.505	1.0	1.0	3.22E+02	4.31E-03	3.22E+02
Mercury	0.024	0.20	1.08	1.0	1.0	4.67E-02	3.00E-05	4.67E-02	0.03	0.10	1.08	1.0	1.0	6.78E-02	1.46E-05	6.78E-02
Molybdenum	1.1	0.17	1.15	1.0	1.0	2.28E+00	2.60E-05	2.28E+00	0.92	1.2	1.15	1.0	1.0	1.91E+00	1.75E-04	1.91E+00
Nickel	21.0	1.49	1.33	1.0	1.0	5.04E+01	2.24E-04	5.04E+01	12.6	3.6	1.43	1.0	1.0	3.23E+01	5.34E-04	3.23E+01
Selenium	0.81	5.8	0.46	0.40	1.0	2.69E-01	8.70E-04	2.70E-01	1.6	1.9	0.93	0.40	1.0	1.09E+00	2.90E-04	1.09E+00
Silver	0.57	0.03	0.18	1.0	1.0	1.85E-01	4.80E-06	1.85E-01	0.72	1.0	0.18	1.0	1.0	2.35E-01	1.52E-04	2.35E-01
Strontium	193	149	1.0	1.0	1.0	3.47E+02	2.24E-02	3.47E+02	193	129	1.0	1.0	1.0	3.47E+02	1.93E-02	3.47E+02
Thallium	13.8	12.5	0.71	1.0	1.0	1.76E+01	1.88E-03	1.76E+01	4.5	2.1	0.71	1.0	1.0	5.80E+00	3.08E-04	5.80E+00
Vanadium	49.0	0.91	1.28	1.0	1.0	1.13E+02	1.37E-04	1.13E+02	19.8	3.9	0.62	1.0	1.0	2.22E+01	5.87E-04	2.22E+01
Zinc	58.7	629	0.84	1.0	1.0	8.88E+01	9.44E-02	8.89E+01	43.6	93.7	0.84	1.0	1.0	6.59E+01	1.41E-02	6.60E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
EDD - Estimated Daily Dose
DF - Dose Fraction for invertebrates
BAV - Bioavailability Adjustment Factor
BSAF - Biota-Sediment Accumulation Factor (for emergent aquatic insects)
** - Aluminum, antimony, cadmium, iron, lead, mercury, nickel, and silver were not selected as COPECs in fish. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
~ -Beryllium was not selected as COPECs in surface water. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations
1 $EDD_{diet} = IR_{diet} \times BSAF \times C_{sed} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 $Total\ EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 0.75
Body Weight (BW) 0.02
IR_{diet} 0.048
IR_{water} 0.004

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]^0.4

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.51
Estimated Daily Doses for Tree Swallows at the Upstream Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	BAV*	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD	Sediment (mg/kg, wet weight)**	Surface Water (ug/L)~	BSAF	BAV*	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD
Metals																
Aluminum	6600	357	0.098	1.0	1.0	1.16E+03	5.36E-02	1.16E+03	5600	178	0.098	1.0	1.0	9.88E+02	2.67E-02	9.88E+02
Antimony	0.19	0.07	0.2	1.0	1.0	6.84E-02	9.75E-06	6.84E-02	3.5	9.4	0.2	1.0	1.0	1.27E+00	1.40E-03	1.27E+00
Arsenic	3.0	100	0.127	1.0	1.0	6.86E-01	1.50E-02	7.01E-01	4.9	45.8	0.127	0.1	1.0	1.41E-01	6.87E-03	1.48E-01
Barium	187	26.0	0.951	1.0	1.0	3.20E+02	3.90E-03	3.20E+02	79.4	21.3	0.951	1.0	1.0	1.36E+02	3.20E-03	1.36E+02
Beryllium	1.6	5.0	0.13	1.0	1.0	3.74E-01	7.50E-04	3.75E-01	0.75	4.1	0.13	1.0	1.0	1.76E-01	6.16E-04	1.76E-01
Cadmium	1.5	2.5	0.31	1.0	1.0	8.33E-01	3.75E-04	8.34E-01	0.53	2.1	0.00	1.0	1.0	3.84E-03	3.12E-04	4.16E-03
Chromium	37.0	1.3	0.588	1.0	1.0	3.92E+01	1.95E-04	3.92E+01	20.9	3.8	0.588	1.0	1.0	2.21E+01	5.70E-04	2.21E+01
Cobalt	4.5	0.24	0.94	1.0	1.0	7.61E+00	3.60E-05	7.61E+00	2.8	2.0	0.73	1.0	1.0	3.63E+00	2.96E-04	3.63E+00
Copper	4.5	1.1	1.28	0.53	1.0	5.50E+00	1.65E-04	5.50E+00	3.2	2.7	1.27	0.53	1.0	3.88E+00	4.05E-04	3.88E+00
Iron	6420	318	0.072	1.0	1.0	8.32E+02	4.77E-02	8.32E+02	4383	166	0.072	1.0	1.0	5.68E+02	2.49E-02	5.68E+02
Lead	9.6	0.50	0.066	0.43	1.0	4.90E-01	7.50E-05	4.90E-01	7.5	7.2	0.066	0.43	1.0	3.83E-01	1.07E-03	3.84E-01
Manganese	475	32.2	0.505	1.0	1.0	4.32E+02	4.83E-03	4.32E+02	278	24.1	0.505	1.0	1.0	2.53E+02	3.62E-03	2.53E+02
Mercury	0.03	0.1	1.08	1.0	1.0	5.83E-02	7.50E-06	5.83E-02	0.02	0.05	1.08	1.1	1.0	4.20E-02	7.50E-06	4.20E-02
Molybdenum	0.16	0.20	1.15	1.0	1.0	3.31E-01	3.00E-05	3.31E-01	0.16	1.2	1.15	1.0	1.0	3.31E-01	1.80E-04	3.31E-01
Nickel	11.7	0.65	1.44	1.0	1.0	3.03E+01	9.75E-05	3.03E+01	7.8	1.7	1.51	1.0	1.0	2.11E+01	2.58E-04	2.12E+01
Selenium	5.0	1.7	2.84	0.40	1.0	1.02E+01	2.55E-04	1.02E+01	1.8	0.37	1.03	0.40	1.0	1.34E+00	5.52E-05	1.34E+00
Silver	0.28	0.02	0.18	1.0	1.0	9.07E-02	2.25E-06	9.07E-02	0.76	0.58	0.18	1.0	1.0	2.46E-01	8.75E-05	2.46E-01
Strontium	198	197	1.0	1.0	1.0	3.56E+02	2.96E-02	3.56E+02	198	133	1.0	1.0	1.0	3.56E+02	2.00E-02	3.56E+02
Thallium	17.5	2.6	0.7	1.0	1.0	2.24E+01	3.83E-04	2.24E+01	9.1	0.41	0.71	1.0	1.0	1.16E+01	6.14E-05	1.16E+01
Vanadium	38.0	0.91	1.10	1.0	1.0	7.49E+01	1.37E-04	7.49E+01	20.3	0.86	1.10	1.0	1.0	4.01E+01	1.29E-04	4.01E+01
Zinc	33.0	10.7	0.84	1.0	1.0	4.99E+01	1.61E-03	4.99E+01	22.2	4.4	0.84	1.0	1.0	3.36E+01	6.59E-04	3.36E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the east branch of the Ompompanoosuc River.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction for invertebrates
BAV - Bioavailability Adjustment Factor
BSAF - Biota-Sediment Accumulation Factor (for emergent aquatic insects)
** - Aluminum, antimony, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, vanadium, and zinc were not selected as COPECs in sediment. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
~ -Beryllium, cadmium, selenium, and thallium were not selected as COPECs in surface water. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.

Equations
1 $EDD_{diet} = IR_{diet} X BSAF X C_{sed} X DF_i X AUF X BAV / BW$
2 $EDD_{water} = IR_{water} X C_{water} X AUF / BW$
3 Total EDD = $EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 0.75
Body Weight (BW) 0.02
IR_{diet} 0.048
IR_{water} 0.004

BSAF Calculations

Cadmium	0.191+0.668*LOG[sediment]
Cobalt	0.395+0.121*[sediment]
Copper	1.23+0.079*LOG[sediment]
Selenium	1.422*[sediment]^0.4
Vanadium	-1.531+0.722*LN(sediment)

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.52
Estimated Daily Doses for the Eastern Small-footed Bats at School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD
Metals																
Aluminum	12000	494	0.098	1.0	1.0	1.03E+03	9.88E-02	1.03E+03	7007	395	0.098	1.0	1.0	6.04E+02	7.89E-02	6.04E+02
Antimony	2.4	0.67	0.2	1.0	1.0	4.21E-01	1.34E-04	4.21E-01	3.5	13.6	0.2	1.0	1.0	6.19E-01	2.73E-03	6.22E-01
Arsenic	2.8	0.19	0.127	1.0	1.0	3.13E-01	3.80E-05	3.13E-01	2.0	32.5	0.127	1.0	1.0	2.26E-01	6.49E-03	2.32E-01
Barium	106	18.8	0.951	1.0	1.0	8.89E+01	3.76E-03	8.89E+01	62.1	17.4	0.951	1.0	1.0	5.19E+01	3.48E-03	5.19E+01
Beryllium	1.6	0.08	0.13	1.0	1.0	1.84E-01	1.60E-05	1.84E-01	0.56	2.6	0.13	1.0	1.0	6.42E-02	5.12E-04	6.48E-02
Cadmium^	0.49	0.23	-0.02	0.54	1.0	-3.71E-03	4.54E-05	-3.67E-03	0.58	0.41	0.03	0.54	1.0	9.61E-03	8.16E-05	9.69E-03
Chromium	23.3	2.0	0.588	0.09	1.0	1.08E+00	3.97E-04	1.08E+00	19.8	3.0	0.588	0.09	1.0	9.24E-01	6.03E-04	9.25E-01
Cobalt	24.7	6.8	3.39	1.0	1.0	7.37E+01	1.35E-03	7.37E+01	13.5	4.6	2.03	1.0	1.0	2.42E+01	9.14E-04	2.42E+01
Copper	489	222	1.44	1.0	1.0	6.21E+02	4.43E-02	6.21E+02	300	117	1.43	1.0	1.0	3.76E+02	2.34E-02	3.77E+02
Iron	58800	569	0.072	1.0	1.0	3.73E+03	1.14E-01	3.73E+03	14267	414	0.072	1.0	1.0	9.04E+02	8.27E-02	9.04E+02
Lead	31.4	2.4	0.066	1.0	1.0	1.82E+00	4.80E-04	1.82E+00	7.9	3.8	0.066	1.0	1.0	4.60E-01	7.60E-04	4.61E-01
Manganese	655	67.0	0.505	1.0	1.0	2.91E+02	1.34E-02	2.91E+02	442	41.5	0.505	1.0	1.0	1.96E+02	8.30E-03	1.96E+02
Mercury	0.02	0.17	1.08	0.25	1.0	5.70E-03	3.40E-05	5.74E-03	0.03	0.09	1.08	0.25	1.0	6.81E-03	1.85E-05	6.82E-03
Molybdenum	2.3	0.18	1.15	1.0	1.0	2.30E+00	3.56E-05	2.30E+00	1.2	1.6	1.15	1.0	1.0	1.23E+00	3.25E-04	1.23E+00
Nickel	22.0	3.3	1.32	1.0	1.0	2.56E+01	6.69E-04	2.56E+01	12.9	3.1	1.42	1.0	1.0	1.61E+01	6.19E-04	1.61E+01
Selenium	2.8	8.5	1.57	0.40	1.0	1.53E+00	1.70E-03	1.53E+00	2.3	1.8	1.33	0.40	1.0	1.09E+00	3.52E-04	1.09E+00
Silver	0.49	0.67	0.18	1.0	1.0	7.76E-02	1.34E-04	7.78E-02	0.67	0.97	0.18	1.0	1.0	1.06E-01	1.94E-04	1.06E-01
Strontium	212	160	1.0	1.0	1.0	1.86E+02	3.20E-02	1.87E+02	194	142	1.0	1.0	1.0	1.71E+02	2.85E-02	1.71E+02
Vanadium	34.3	0.53	1.02	1.0	1.0	3.08E+01	1.07E-04	3.08E+01	23.5	2.2	0.75	1.0	1.0	1.54E+01	4.41E-04	1.54E+01
Zinc	64.3	37.6	0.84	1.0	1.0	4.75E+01	7.52E-03	4.76E+01	57.4	23.5	0.84	1.0	1.0	4.24E+01	4.69E-03	4.24E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction of Invertebrates
BSAFs - Biota-Sediment Accumulation Factors for emergent aquatic invertebrates
BAV - Bioavailability Adjustment Factor
*- Aluminum, antimony, cadmium, iron, lead, mercury, nickel, and silver were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
** - Beryllium was not selected as a surface water COPEC. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 0.005
IR_{diet} 0.0044
IR_{water} 0.001

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]*0.4
Vanadium	-1.531 + 0.722*LN[sediment]

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel (1998b).

Attachment 5.53
Estimated Daily Doses for the Eastern Small-footed Bats at the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		Dose (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD
Metals																
Aluminum	12000	599	0.098	1.0	1.0	1.03E+03	1.20E-01	1.03E+03	7308	183	0.098	1.0	1.0	6.30E+02	3.65E-02	6.30E+02
Antimony	0.15	0.10	0.2	1.0	1.0	2.64E-02	2.00E-05	2.64E-02	3.2	11.3	0.2	1.0	1.0	5.64E-01	2.27E-03	5.66E-01
Arsenic	3.0	0.18	0.127	1.0	1.0	3.35E-01	3.60E-05	3.35E-01	2.2	31.7	0.127	1.0	1.0	2.40E-01	6.35E-03	2.47E-01
Barium	148	19.5	0.951	1.0	1.0	1.24E+02	3.89E-03	1.24E+02	64.7	16.6	0.951	1.0	1.0	5.42E+01	3.31E-03	5.42E+01
Beryllium	2.0	5.0	0.13	1.0	1.0	2.29E-01	1.00E-03	2.30E-01	0.60	2.8	0.13	1.0	1.0	6.89E-02	5.50E-04	6.95E-02
Cadmium	1.5	0.02	0.31	0.54	1.0	2.20E-01	4.00E-06	2.20E-01	0.57	1.1	0.03	0.54	1.0	7.63E-03	2.17E-04	7.85E-03
Chromium	52.0	3.0	0.588	0.09	1.0	2.42E+00	6.00E-04	2.42E+00	23.1	2.7	0.588	0.09	1.0	1.08E+00	5.38E-04	1.08E+00
Cobalt	6.0	0.50	1.12	1.0	1.0	5.88E+00	1.00E-04	5.88E+00	5.0	1.3	1.0044	1.0	1.0	4.45E+00	2.61E-04	4.45E+00
Copper	14.6	1.3	1.32	1.0	1.0	1.70E+01	2.55E-04	1.70E+01	10.5	1.6	1.31	1.0	1.0	1.21E+01	3.12E-04	1.21E+01
Iron	25800	726	0.072	1.0	1.0	1.63E+03	1.45E-01	1.63E+03	9928	163	0.072	1.0	1.0	6.29E+02	3.25E-02	6.29E+02
Lead	11.2	0.82	0.066	1.0	1.0	6.50E-01	1.64E-04	6.51E-01	5.4	6.0	0.066	1.0	1.0	3.12E-01	1.20E-03	3.13E-01
Manganese	599	28.1	0.505	1.0	1.0	2.66E+02	5.62E-03	2.66E+02	442	16.3	0.505	1.0	1.0	1.96E+02	3.26E-03	1.96E+02
Mercury	0.01	0.10	1.08	0.25	1.0	3.33E-03	2.00E-05	3.35E-03	0.03	0.07	1.08	0.25	1.0	7.29E-03	1.43E-05	7.31E-03
Molybdenum	0.28	0.34	1.15	1.0	1.0	2.83E-01	6.80E-05	2.83E-01	0.55	1.2	1.15	1.0	1.0	5.55E-01	2.32E-04	5.56E-01
Nickel	21.0	0.76	1.33	1.0	1.0	2.46E+01	1.52E-04	2.46E+01	13.3	1.3	1.42	1.0	1.0	1.66E+01	2.70E-04	1.66E+01
Selenium	0.30	1.7	0.17	0.40	1.0	1.80E-02	3.40E-04	1.84E-02	0.70	0.51	0.40	0.40	1.0	9.82E-02	1.03E-04	9.83E-02
Silver	0.36	2.5	0.18	1.0	1.0	5.70E-02	5.00E-04	5.75E-02	0.97	0.44	0.18	1.0	1.0	1.54E-01	8.72E-05	1.54E-01
Strontium	257	169	1.0	1.0	1.0	2.26E+02	3.37E-02	2.26E+02	230	139	1.0	1.0	1.0	2.02E+02	2.78E-02	2.02E+02
Thallium	20.0	2.6	0.71	1.0	1.0	1.25E+01	5.10E-04	1.25E+01	2.8	0.58	0.71	1.0	1.0	1.73E+00	1.17E-04	1.73E+00
Vanadium	29.7	0.57	0.92	1.0	1.0	2.40E+01	1.15E-04	2.40E+01	21.5	0.92	0.68	1.0	1.0	1.29E+01	1.84E-04	1.29E+01
Zinc	40.1	24.3	0.84	1.0	1.0	2.97E+01	4.85E-03	2.97E+01	28.8	7.3	0.84	1.0	1.0	2.13E+01	1.46E-03	2.13E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction of invertebrates
BSAFs - Biota-Sediment Accumulation Factors for emergent aquatic invertebrates
BAV - Bioavailability Adjustment Factor
*-Aluminum, antimony, arsenic, cobalt, copper, iron, lead, nickel, and zinc were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
**- Beryllium, selenium, and thallium were not selected as surface water COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 0.005
IR_{diet} 0.0044
IR_{water} 0.001

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]^0.4
Vanadium	-1.531 + 0.722*LN[sediment]

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel (1998b).

Attachment 5.54
Estimated Daily Doses for the Eastern Small-footed Bats at the EBOR
Ely Mine Copper Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		EDD (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD
Metals																
Aluminum	14000	380	0.098	1.0	1.0	1.21E+03	7.60E-02	1.21E+03	7847	172	0.098	1.0	1.0	6.77E+02	3.44E-02	6.77E+02
Antimony	1.8	0.76	0.2	1.0	1.0	3.17E-01	1.52E-04	3.17E-01	3.7	10.4	0.2	1.0	1.0	6.49E-01	2.08E-03	6.51E-01
Arsenic	5.0	0.20	0.127	1.0	1.0	5.59E-01	4.00E-05	5.59E-01	2.6	25.5	0.127	1.0	1.0	2.92E-01	5.10E-03	2.97E-01
Barium	90.0	19.4	0.951	1.0	1.0	7.54E+01	3.88E-03	7.54E+01	46.3	19.9	0.951	1.0	1.0	3.88E+01	3.97E-03	3.88E+01
Beryllium	1.8	5.0	0.13	1.0	1.0	2.06E-01	1.00E-03	2.07E-01	0.40	2.8	0.13	1.0	1.0	4.52E-02	5.55E-04	4.57E-02
Cadmium^	0.18	0.09	-0.31	0.54	1.0	-2.62E-02	1.78E-05	-2.62E-02	0.62	0.96	0.05	0.54	1.0	1.47E-02	1.92E-04	1.48E-02
Chromium	31.5	1.2	0.588	0.09	1.0	1.47E+00	2.40E-04	1.47E+00	18.9	3.0	0.588	0.09	1.0	8.78E-01	6.04E-04	8.79E-01
Cobalt	28.5	0.67	3.84	1.0	1.0	9.64E+01	1.35E-04	9.64E+01	9.3	3.5	1.52	1.0	1.0	1.25E+01	7.00E-04	1.25E+01
Copper	127	23.9	1.40	1.0	1.0	1.56E+02	4.78E-03	1.56E+02	76.3	13.3	1.38	1.0	1.0	9.26E+01	2.66E-03	9.26E+01
Iron	22800	332	0.072	1.0	1.0	1.44E+03	6.63E-02	1.44E+03	10694	196	0.072	1.0	1.0	6.78E+02	3.92E-02	6.78E+02
Lead	11.0	0.43	0.066	1.0	1.0	6.39E-01	8.58E-05	6.39E-01	6.0	4.5	0.066	1.0	1.0	3.49E-01	8.93E-04	3.49E-01
Manganese	475	34.3	0.505	1.0	1.0	2.11E+02	6.86E-03	2.11E+02	355	28.8	0.505	1.0	1.0	1.58E+02	5.75E-03	1.58E+02
Mercury	0.02	0.20	1.08	0.25	1.0	5.70E-03	4.00E-05	5.74E-03	0.03	0.10	1.08	0.25	1.0	8.28E-03	1.94E-05	8.30E-03
Molybdenum	1.1	0.17	1.15	1.0	1.0	1.11E+00	3.46E-05	1.11E+00	0.92	1.2	1.15	1.0	1.0	9.35E-01	2.33E-04	9.35E-01
Nickel	21.0	1.5	1.33	1.0	1.0	2.46E+01	2.98E-04	2.46E+01	12.6	3.6	1.43	1.0	1.0	1.58E+01	7.12E-04	1.58E+01
Selenium	0.81	5.8	0.46	0.40	1.0	1.31E-01	1.16E-03	1.33E-01	1.6	1.9	0.93	0.40	1.0	5.31E-01	3.86E-04	5.32E-01
Silver	0.57	0.03	0.18	1.0	1.0	9.03E-02	6.40E-06	9.03E-02	0.72	1.0	0.18	1.0	1.0	1.15E-01	2.03E-04	1.15E-01
Strontium	193	149	1.0	1.0	1.0	1.70E+02	2.98E-02	1.70E+02	193	129	1.0	1.0	1.0	1.70E+02	2.58E-02	1.70E+02
Thallium	13.8	12.5	0.71	1.0	1.0	8.59E+00	2.50E-03	8.59E+00	4.5	2.1	0.71	1.0	1.0	2.84E+00	4.11E-04	2.84E+00
Vanadium	49.0	0.91	1.28	1.0	1.0	5.51E+01	1.82E-04	5.51E+01	19.8	3.9	0.62	1.0	1.0	1.09E+01	7.82E-04	1.09E+01
Zinc	58.7	629	0.84	1.0	1.0	4.34E+01	1.26E-01	4.35E+01	43.6	93.7	0.84	1.0	1.0	3.22E+01	1.87E-02	3.23E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the east branch of the Ompompanoosuc River.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
DF - Dose Fraction of Invertebrates
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
BSAFs - Biota-Sediment Accumulation Factors for emergent aquatic invertebrates
BAV - Bioavailability Adjustment Factor
*- Aluminum, antimony, arsenic, cadmium, chromium, cobalt, iron, lead, mercury, nickel, and vanadium were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
**- Beryllium, silver, and thallium were not selected as surface water COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW)	0.005
IR_{diet}	0.0044
IR_{water}	0.001

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]^0.4
Vanadium	-1.531 + 0.722*LN[sediment]

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel (1998b).

Attachment 5.55
Estimated Daily Doses for the Eastern Small-footed Bats at Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)						CTE Exposure Point Concentration		Dose (mg/kg bw-day)					
			Diet				Water				Diet				Water	
COPECs	Sediment (mg/kg, wet weight)*	Surface Water (ug/L)**	BSAF	BAV~	DF	EDD_{diet} 1	EDD_{water} 2	Total EDD	Sediment (mg/kg, wet weight)	Surface Water (ug/L)	BSAF	BAV	DF	EDD_{diet} 1	EDD_{water} 2	Total EDD
Metals																
Aluminum	6600	357	0.098	1.0	1.0	5.69E+02	7.15E-02	5.69E+02	5600	178	0.098	1.0	1.0	4.83E+02	3.56E-02	4.83E+02
Antimony	0.19	0.07	0.2	1.0	1.0	3.34E-02	1.30E-05	3.35E-02	3.5	9.4	0.2	1.0	1.0	6.19E-01	1.87E-03	6.21E-01
Arsenic	3.0	100	0.127	1.0	1.0	3.35E-01	2.00E-02	3.55E-01	4.9	45.8	0.127	1.0	1.0	5.44E-01	9.16E-03	5.53E-01
Barium	187	26.0	0.951	1.0	1.0	1.56E+02	5.20E-03	1.57E+02	79.4	21.3	0.951	1.0	1.0	6.64E+01	4.26E-03	6.64E+01
Beryllium	1.6	5.0	0.13	1.0	1.0	1.83E-01	1.00E-03	1.84E-01	0.75	4.1	0.13	1.0	1.0	8.58E-02	8.22E-04	8.66E-02
Cadmium	1.5	2.5	0.31	0.54	1.0	2.20E-01	5.00E-04	2.20E-01	0.53	2.1	0.004	0.54	1.0	1.01E-03	4.16E-04	1.43E-03
Chromium	37.0	1.3	0.588	0.09	1.0	1.72E+00	2.60E-04	1.72E+00	20.9	3.8	0.588	0.09	1.0	9.72E-01	7.60E-04	9.73E-01
Cobalt	4.5	0.24	0.94	1.0	1.0	3.72E+00	4.80E-05	3.72E+00	2.8	2.0	0.73	1.0	1.0	1.78E+00	3.94E-04	1.78E+00
Copper	4.5	1.1	1.28	1.0	1.0	5.08E+00	2.20E-04	5.08E+00	3.2	2.7	1.27	1.0	1.0	3.58E+00	5.40E-04	3.58E+00
Iron	6420	318	0.072	1.0	1.0	4.07E+02	6.37E-02	4.07E+02	4383	166	0.072	1.0	1.0	2.78E+02	3.33E-02	2.78E+02
Lead	9.6	0.50	0.066	1.0	1.0	5.58E-01	1.00E-04	5.58E-01	7.5	7.2	0.066	1.0	1.0	4.36E-01	1.43E-03	4.37E-01
Manganese	475	32.2	0.505	1.0	1.0	2.11E+02	6.43E-03	2.11E+02	278	24.1	0.505	1.0	1.0	1.24E+02	4.83E-03	1.24E+02
Mercury	0.03	0.05	1.08	0.25	1.0	7.13E-03	1.00E-05	7.14E-03	0.02	0.1	1.08	0.25	1.0	4.75E-03	1.00E-05	4.76E-03
Molybdenum	0.16	0.20	1.15	1.0	1.0	1.62E-01	4.00E-05	1.62E-01	0.16	1.2	1.15	1.0	1.0	1.62E-01	2.40E-04	1.62E-01
Nickel	11.7	0.65	1.44	1.0	1.0	1.48E+01	1.30E-04	1.48E+01	7.8	1.7	1.51	1.0	1.0	1.03E+01	3.44E-04	1.03E+01
Selenium	5.0	1.7	2.84	0.40	1.0	5.01E+00	3.40E-04	5.01E+00	1.8	0.37	1.03	0.40	1.0	6.55E-01	7.36E-05	6.55E-01
Silver	0.28	0.02	0.18	1.0	1.0	4.44E-02	3.00E-06	4.44E-02	0.76	0.58	0.18	1.0	1.0	1.20E-01	1.17E-04	1.21E-01
Strontium	198	197	1.0	1.0	1.0	1.74E+02	3.94E-02	1.74E+02	198	133	1.0	1.0	1.0	1.74E+02	2.66E-02	1.74E+02
Thallium	17.5	2.6	0.71	1.0	1.0	1.09E+01	5.10E-04	1.09E+01	9.1	0.41	0.71	1.0	1.0	5.65E+00	8.18E-05	5.65E+00
Vanadium	38.0	0.91	1.10	1.0	1.0	3.66E+01	1.82E-04	3.66E+01	20.3	0.86	0.64	1.0	1.0	1.15E+01	1.72E-04	1.15E+01
Zinc	33.0	10.7	0.84	1.0	1.0	2.44E+01	2.14E-03	2.44E+01	22.2	4.4	0.84	1.0	1.0	1.64E+01	8.79E-04	1.64E+01

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the east branch of the Ompompanoosuc River.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAFs - Biota-Sediment Accumulation Factors
BAV - Bioavailability Adjustment Factor
*- Aluminum, antimony, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, vanadium, and zinc were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
**- Beryllium, cadmium, selenium, and thallium were not selected as surface water COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
y Weight (BW) 0.005
IR_{diet} 0.0044
IR_{water} 0.001

BSAF Calculations

Cadmium	0.191+ (0.668*LOG[sediment])
Cobalt	0.395+0.121*[sediment]
Copper	1.23+ (0.079*LOG[sediment])
Selenium	1.422*[sediment]*0.4
Vanadium	-1.531 + 0.722*LN[sediment]

BSAF for nickel equals the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel (1998b).

Attachment 5.56
Estimated Daily Dose for the Belted Kingfishers at School House Brook
Ely Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration			EDD (mg/kg bw-day)						
				Diet					Water	
COPECs	Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	$Dose_{diet}$ [1]	$Dose_{water}$ [2]	Total EDD
Metals										
Aluminum	12000	12.4	494	0.098	1.0	0.1	0.9	1.00E+02	5.34E-02	1.00E+02
Antimony	2.4	0.40	0.7	0.2	1.0	0.1	0.9	3.17E-01	7.24E-05	3.17E-01
Arsenic	2.8	0.15	0.2	0.127	1.0	0.1	0.9	1.33E-01	2.05E-05	1.33E-01
Barium	106	2.3	18.8	0.951	1.0	0.1	0.9	9.46E+00	2.03E-03	9.47E+00
Beryllium	1.6	0.01	0.08	0.13	1.0	0.1	0.9	1.98E-02	8.65E-06	1.98E-02
Cadmium	0.49	0.07	0.23	3.07	1.0	0.1	0.9	1.66E-01	2.45E-05	1.66E-01
Chromium	23.3	0.50	2.0	0.588	1.0	0.1	0.9	1.41E+00	2.14E-04	1.41E+00
Cobalt	24.7	0.11	6.8	3.4	1.0	0.1	0.9	6.58E+00	7.30E-04	6.58E+00
Copper	489	7.9	222	2.34	0.53	0.1	0.9	5.00E+01	2.40E-02	5.01E+01
Iron	58800	46.9	569	0.072	1.00	0.1	0.9	3.62E+02	6.15E-02	3.62E+02
Lead	31.4	1.2	2.4	0.066	0.43	0.1	0.9	4.21E-01	2.60E-04	4.21E-01
Manganese	655	4.2	67.0	0.505	1.0	0.1	0.9	2.87E+01	7.24E-03	2.87E+01
Mercury (inorganic)	0.02	0.02	0.17	1.74	1.0	0.1	0.9	1.79E-02	1.84E-05	1.79E-02
Molybdenum	2.3	0.15	0.18	1.15	1.0	0.1	0.9	3.08E-01	1.92E-05	3.08E-01
Nickel	22.0	0.20	3.3	1.3	1.0	0.1	0.9	2.40E+00	3.62E-04	2.40E+00
Selenium	2.8	0.50	8.5	3.93	0.44	0.1	0.9	5.25E-01	9.19E-04	5.26E-01
Silver	0.49	0	0.67	0.18	1.0	0.1	0.9	6.85E-03	7.24E-05	6.93E-03
Strontium	212	0	160	1.00	1.0	0.1	0.9	1.65E+01	1.73E-02	1.65E+01
Vanadium	34.3	0.10	0.53	1.020	1.0	0.1	0.9	2.79E+00	5.77E-05	2.79E+00
Zinc	64.3	40.9	37.6	2.6	1.0	0.1	0.9	4.16E+01	4.06E-03	4.16E+01

	CTE Exposure Point Concentration			EDD (mg/kg bw-day)						
				Diet					Water	
COPECs	Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	EDD_{water} [2]	Total EDD[3]
Metals										
Aluminum	7007	5.7	395	0.098	1.0	0.1	0.9	5.73E+01	4.27E-02	5.74E+01
Antimony	3.5	0.12	13.6	0.2	1.0	0.1	0.9	1.36E-01	1.47E-03	1.38E-01
Arsenic	2.0	0.15	32.5	0.127	1.0	0.1	0.9	1.25E-01	3.51E-03	1.28E-01
Barium	62.1	1.8	17.4	0.951	1.0	0.1	0.9	5.83E+00	1.88E-03	5.84E+00
Beryllium	0.56	0.01	2.6	0.13	1.0	0.1	0.9	9.17E-03	2.77E-04	9.45E-03
Cadmium	0.58	0.04	0.41	3.07	1.0	0.1	0.9	1.66E-01	4.41E-05	1.66E-01
Chromium	19.8	0.38	3.0	0.588	1.0	0.1	0.9	1.17E+00	3.26E-04	1.17E+00
Cobalt	13.5	0.06	4.6	2.03	1.0	0.1	0.9	2.17E+00	4.94E-04	2.17E+00
Copper	300	4.6	117	2.28	0.53	0.1	0.9	2.98E+01	1.27E-02	2.99E+01
Iron	14267	34.7	414	0.072	1.00	0.1	0.9	1.04E+02	4.47E-02	1.04E+02
Lead	7.9	0.15	3.8	0.066	0.43	0.1	0.9	6.19E-02	4.11E-04	6.23E-02
Manganese	442	3.6	41.5	0.505	1.0	0.1	0.9	1.99E+01	4.48E-03	1.99E+01
Mercury (inorganic)	0.03	0.01	0.09	1.74	1.0	0.1	0.9	1.28E-02	1.00E-05	1.28E-02
Molybdenum	1.2	0.15	1.6	1.15	1.0	0.1	0.9	2.13E-01	1.75E-04	2.14E-01
Nickel	12.9	0.17	3.1	1.42	1.0	0.1	0.9	1.54E+00	3.35E-04	1.54E+00
Selenium	2.3	0.41	1.8	3.32	0.44	0.1	0.9	3.92E-01	1.91E-04	3.92E-01
Silver	0.67	0	0.97	0.18	1.0	0.1	0.9	9.38E-03	1.05E-04	9.48E-03
Strontium	194	0	142	1.0	1.0	0.1	0.9	1.51E+01	1.54E-02	1.51E+01
Vanadium	23.5	0.10	2.2	0.75	1.0	0.1	0.9	1.43E+00	2.38E-04	1.43E+00
Zinc	57.4	34.1	23.5	2.58	1.0	0.1	0.9	3.54E+01	2.54E-03	3.54E+01

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the impacted reach of School House Brook.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BSAF - Biota-Sediment Accumulation Factor for benthic invertebrates
BAV - Bioavailability Adjustment Factor
* - Aluminum, antimony, cadmium, iron, lead, mercury, nickel, and silver were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration. Silver and Thallium were not analyzed for in fish.
** - Arsenic, beryllium, and molybdenum were not selected as fish COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE values represents the mean concentration. Silver and strontium were not analyzed for, value is zero.
*** - Beryllium was not selected as surface water COPECs. The RME Value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. THE CTE values represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed; 100% bioavailability was assumed.

Equations
1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 0.148
IR_{diet} 0.115
IR_{water} 0.016

BSAF Calculations

Cobalt	0.395+(0.121*[sediment])
Selenium	1.422*[sediment]*.40
Vanadium	-1.531+(0.722*LN[sediment])

BSAFs for copper, nickel, and zinc equal the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Estimated Daily Doses for Belted Kingfishers at the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

	RME			EDD (mg/kg bw-day)							CTE			EDD (mg/kg bw-day)						
	Exposure Point Concentration			Diet					Water		Exposure Point Concentration			Diet					Water	
COPECs	Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	EDD_{water} [2]	Total EDD	Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	EDD_{water} [2]	Total EDD
Metals																				
Aluminum	12000	26.5	599	0.098	1.0	0.1	0.9	1.10E+02	6.47E-02	1.10E+02	7308	9.3	183	0.098	1.0	0.1	0.9	6.22E+01	1.97E-02	6.22E+01
Antimony	0.15	0.05	0.10	0.2	1.0	0.1	0.9	3.73E-02	1.08E-05	3.73E-02	3.2	0.05	11.3	0.2	1.0	0.1	0.9	8.48E-02	1.23E-03	8.60E-02
Arsenic	3.0	0.15	0.18	0.127	1.0	0.1	0.9	1.35E-01	1.95E-05	1.35E-01	2.2	0.15	31.7	0.127	1.0	0.1	0.9	1.26E-01	3.43E-03	1.30E-01
Barium	148	1.13	19.5	0.951	1.0	0.1	0.9	1.17E+01	2.10E-03	1.17E+01	64.7	0.58	16.6	0.951	1.0	0.1	0.9	5.19E+00	1.79E-03	5.19E+00
Beryllium	2.0	0.01	5.0	0.13	1.0	0.1	0.9	2.37E-02	5.41E-04	2.42E-02	0.60	0.01	2.8	0.13	1.0	0.1	0.9	9.58E-03	2.97E-04	9.88E-03
Cadmium	1.5	0.08	0.02	3.07	1.0	0.1	0.9	4.14E-01	2.16E-06	4.14E-01	0.57	0.05	1.1	3.07	1.0	0.1	0.9	1.70E-01	1.17E-04	1.70E-01
Chromium	52.0	0.60	3.0	0.588	1.0	0.1	0.9	2.79E+00	3.24E-04	2.79E+00	23.1	0.46	2.7	0.588	1.0	0.1	0.9	1.38E+00	2.91E-04	1.38E+00
Cobalt	8.4	0.06	0.50	1.4	1.0	0.1	0.9	9.63E-01	5.41E-05	9.63E-01	5.0	0.04	1.3	1.00	1.0	0.1	0.9	4.23E-01	1.41E-04	4.23E-01
Copper	24.0	1.9	1.3	1.97	0.53	0.1	0.9	2.66E+00	1.38E-04	2.66E+00	10.5	1.4	1.6	1.87	0.53	0.1	0.9	1.34E+00	1.69E-04	1.34E+00
Iron	25800	0.02	726	0.072	1.00	0.1	0.9	1.44E+02	7.85E-02	1.44E+02	9928	0.01	163	0.072	1.00	0.1	0.9	5.56E+01	1.76E-02	5.56E+01
Lead	11.2	60.5	0.82	0.066	0.43	0.1	0.9	1.82E+01	8.86E-05	1.82E+01	5.4	38.6	6.0	0.066	0.43	0.1	0.9	1.16E+01	6.47E-04	1.16E+01
Manganese	599	6.1	28.1	0.505	1.0	0.1	0.9	2.78E+01	3.04E-03	2.78E+01	442	3.8	16.3	0.505	1.0	0.1	0.9	2.00E+01	1.76E-03	2.00E+01
Mercury	0.01	0.06	0.10	1.74	1.0	0.1	0.9	4.39E-02	1.08E-05	4.39E-02	0.03	0.04	0.07	1.74	1.0	0.1	0.9	2.91E-02	7.72E-06	2.91E-02
Molybdenum	0.28	0.15	0.34	1.15	1.0	0.1	0.9	1.30E-01	3.68E-05	1.30E-01	0.55	0.15	1.2	1.15	1.0	0.1	0.9	1.54E-01	1.26E-04	1.54E-01
Nickel	21.0	0.20	0.76	1.3	1.0	0.1	0.9	2.31E+00	8.23E-05	2.31E+00	13.3	0.14	1.3	1.42	1.0	0.1	0.9	1.57E+00	1.46E-04	1.57E+00
Selenium	0.30	0.70	1.7	0.43	0.44	0.1	0.9	2.20E-01	1.84E-04	2.20E-01	0.70	0.56	0.51	0.996	0.44	0.1	0.9	1.95E-01	5.56E-05	1.95E-01
Strontium	257	0	169	1.00	1.0	0.1	0.9	2.00E+01	1.82E-02	2.00E+01	230	0	139	1.00	1.0	0.1	0.9	1.78E+01	1.50E-02	1.78E+01
Thallium	20.0	0.02	2.6	0.71	1.0	0.1	0.9	1.11E+00	2.76E-04	1.11E+00	2.8	0.15	0.58	0.71	1.0	0.1	0.9	2.58E-01	6.31E-05	2.58E-01
Vanadium	29.7	0.20	0.57	0.918	1.0	0.1	0.9	2.26E+00	6.21E-05	2.26E+00	21.5	0.14	0.92	0.68	1.0	0.1	0.9	1.24E+00	9.97E-05	1.24E+00
Zinc	72.0	33.9	24.3	2.6	1.0	0.1	0.9	3.83E+01	2.62E-03	3.83E+01	28.8	24.4	7.3	2.52	1.0	0.1	0.9	2.27E+01	7.90E-04	2.27E+01

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the impacted reach of School House Brook.

mg/kg - milligrams per kilogram

ug/L - micrograms per liter

mg/kg bw-day - milligrams per kilogram of body weight per day

COPECs - Chemicals of Potential Ecological Concern

EDD - Estimated Daily Dose

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

DF - Dose Fraction

BSAF - Biota-Sediment Accumulation Factor for benthic invertebrates

BAV - Bioavailability Adjustment Factor

*-Aluminum, antimony, arsenic, cobalt, copper, iron, lead, mercury, nickel, and zinc were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.

The CTE value represents the mean concentration. Silver and Thallium were not analyzed for in fish

**- Antimony, arsenic, beryllium, molybdenum, and thallium were not selected as fish COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration. Strontium was not analyzed for in fish, value is zero.

***- Beryllium, mercury, selenium, and thallium were not selected as surface water COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.

~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} X C_{fish} X DF_i X AUF X BAV / BW$

2 $EDD_{water} = IR_{water} X C_{water} X AUF / BW$

3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF)	1.0
Body Weight (BW)	0.148
IR_{diet}	0.115
IR_{water}	0.016

BSAF Calculations

Cobalt	0.395+(0.121*[sediment])
Selenium	1.422*[sediment]*.40
Vanadium	-1.531+(0.722*LN[sediment])

BSAFs for copper, nickel, and zinc equal the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.58
Estimated Daily Doses for Belted Kingfishers at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration: Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	EDD (mg/kg bw-day) Diet: BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	$Dose_{diet}$ [1]	Water: $Dose_{water}$ [2]	Total EDD
Metals										
Aluminum	14000	16.8	380	0.098	1.0	0.1	0.9	1.18E+02	4.11E-02	1.18E+02
Antimony	1.8	0.05	0.76	0.2	1.0	0.1	0.9	6.29E-02	8.22E-05	6.30E-02
Arsenic	5.0	0.15	0.20	0.127	1.0	0.1	0.9	1.54E-01	2.16E-05	1.54E-01
Barium	90.0	2.4	19.4	0.951	1.0	0.1	0.9	8.32E+00	2.10E-03	8.33E+00
Beryllium	1.8	0.01	5.0	0.13	1.0	0.1	0.9	2.17E-02	5.41E-04	2.22E-02
Cadmium	0.18	0.07	0.09	3.07	1.0	0.1	0.9	9.19E-02	9.62E-06	9.19E-02
Chromium	31.5	0.30	1.2	0.588	1.0	0.1	0.9	1.65E+00	1.30E-04	1.65E+00
Cobalt	28.5	0.09	0.67	3.8	1.0	0.1	0.9	8.57E+00	7.28E-05	8.57E+00
Copper	127	3.5	23.9	2.36	0.53	0.1	0.9	1.36E+01	2.58E-03	1.36E+01
Iron	22800	50.8	332	0.072	1.0	0.1	0.9	1.63E+02	3.59E-02	1.63E+02
Lead	11.0	0.04	0.43	0.066	0.43	0.1	0.9	3.63E-02	4.64E-05	3.63E-02
Manganese	475	6.4	34.3	0.505	1.0	0.1	0.9	2.31E+01	3.71E-03	2.32E+01
Mercury (inorganic)	0.02	0.02	0.20	1.74	1.0	0.1	0.9	1.86E-02	2.16E-05	1.87E-02
Molybdenum	1.1	0.15	0.17	1.15	1.0	0.1	0.9	2.03E-01	1.87E-05	2.03E-01
Nickel	21.0	0.20	1.5	1.3	1.0	0.1	0.9	2.31E+00	1.61E-04	2.32E+00
Selenium	0.81	0.50	5.8	1.15	0.44	0.1	0.9	1.86E-01	6.27E-04	1.86E-01
Silver	0.57	0	0.03	0.18	1.0	0.1	0.9	7.97E-03	3.46E-06	7.98E-03
Strontium	193	0	149	1.00	1.0	0.1	0.9	1.50E+01	1.61E-02	1.50E+01
Thallium	13.8	0.02	12.5	0.71	1.0	0.1	0.9	7.69E-01	1.35E-03	7.70E-01
Vanadium	49.0	0.1	0.91	1.28	1.0	0.1	0.9	4.94E+00	9.84E-05	4.94E+00
Zinc	58.7	41.6	629	2.6	1.0	0.1	0.9	4.09E+01	6.80E-02	4.09E+01

COPECs	CTE Exposure Point Concentration: Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	EDD (mg/kg bw-day) Diet: BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	Water: EDD_{water} [2]	Total EDD[3]
Metals										
Aluminum	7847	7.1	172	0.098	1.0	0.1	0.9	6.47E+01	1.86E-02	6.47E+01
Antimony	3.7	0.05	10.4	0.2	1.0	0.1	0.9	9.23E-02	1.12E-03	9.34E-02
Arsenic	2.6	0.15	25.5	0.127	1.0	0.1	0.9	1.31E-01	2.76E-03	1.33E-01
Barium	46.3	1.7	19.9	0.951	1.0	0.1	0.9	4.60E+00	2.15E-03	4.60E+00
Beryllium	0.40	0.01	2.8	0.13	1.0	0.1	0.9	7.49E-03	3.00E-04	7.79E-03
Cadmium	0.62	0.04	0.96	3.07	1.0	0.1	0.9	1.76E-01	1.04E-04	1.77E-01
Chromium	18.9	0.27	3.0	0.588	1.0	0.1	0.9	1.05E+00	3.27E-04	1.05E+00
Cobalt	9.3	0.07	3.5	1.52	1.0	0.1	0.9	1.15E+00	3.78E-04	1.15E+00
Copper	76.3	2.1	13.3	2.28	0.53	0.1	0.9	7.93E+00	1.44E-03	7.93E+00
Iron	10694	32.4	196	0.072	1.00	0.1	0.9	8.25E+01	2.12E-02	8.25E+01
Lead	6.0	0.02	4.5	0.066	0.43	0.1	0.9	1.94E-02	4.83E-04	1.99E-02
Manganese	355	4.6	28.8	0.505	1.0	0.1	0.9	1.72E+01	3.11E-03	1.72E+01
Mercury (inorganic)	0.03	0.01	0.10	1.74	1.0	0.1	0.9	1.50E-02	1.05E-05	1.50E-02
Molybdenum	0.92	0.15	1.17	1.15	1.0	0.1	0.9	1.87E-01	1.26E-04	1.88E-01
Nickel	12.6	0.14	3.6	1.38	1.0	0.1	0.9	1.45E+00	3.85E-04	1.45E+00
Selenium	1.6	0.36	1.9	2.32	0.44	0.1	0.9	2.41E-01	2.09E-04	2.41E-01
Silver	0.72	0	1.0	0.18	1.0	0.1	0.9	1.01E-02	1.10E-04	1.02E-02
Strontium	193	0	129	1.00	1.0	0.1	0.9	1.50E+01	1.39E-02	1.50E+01
Thallium	4.5	0.02	2.1	0.71	1.0	0.1	0.9	2.61E-01	2.22E-04	2.61E-01
Vanadium	19.8	0.10	3.9	0.62	1.0	0.1	0.9	1.03E+00	4.23E-04	1.03E+00
Zinc	43.6	33.6	93.7	2.56	1.0	0.1	0.9	3.22E+01	1.01E-02	3.22E+01

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the east branch of the Ompompanoosuc River.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction
BAV - Bioavailability Adjustment Factor
BSAF - Biota-Sediment Accumulation Factor for benthic invertebrates
* - Aluminum, antimony, arsenic, cadmium, chromium, cobalt, iron, lead, mercury, nickel, and vanadium were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
** - Antimony, arsenic, beryllium, molybdenum, thallium, and vanadium were not selected as fish COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
The CTE value represents the mean concentration. Silver and strontium were not analyzed for in fish.
*** - Beryllium, silver, and thallium were not selected as surface water COPECs. Value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed. 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} X C_{fish} X DF_i X AUF X BAV / BW$
2 $EDD_{water} = IR_{water} X C_{water} X AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 0.148
IR_{diet} 0.115
IR_{water} 0.016

BSAF Calculations

Cobalt	0.395+(0.121*[sediment])
Selenium	1.422*[sediment]^0.40
Vanadium	-1.531+(0.722*LN[sediment])

BSAFs for copper, nickel, and zinc equal the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel(1998b).

Attachment 5.59
Estimated Daily Dose for Belted Kingfishers at the Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration			EDD (mg/kg bw-day)							CTE Exposure Point Concentration			EDD (mg/kg bw-day)						
				Diet					Water					Diet					Water	
COPECs	Sediment (mg/kg, wet weight)*	Fish (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	EDD_{water} [2]	Total EDD	Sediment (mg/kg, wet weight)*	Fish Tissue (mg/kg, wet weight)**	Surface Water (ug/L)***	BSAFs	BAV~	$DF_{Invertebrates}$	DF_{Fish}	EDD_{diet} [1]	EDD_{water} [2]	Total EDD
Metals																				
Aluminum	6600	8.9	357	0.098	1.0	0.1	0.9	5.65E+01	3.86E-02	5.65E+01	5600	6.4	178	0.098	1.0	0.1	0.9	4.71E+01	1.93E-02	4.71E+01
Antimony	0.19	0.10	0.07	0.2	1.0	0.1	0.9	7.29E-02	7.03E-06	7.29E-02	3.5	0.07	9.4	0.2	1.0	0.1	0.9	1.01E-01	1.01E-03	1.02E-01
Arsenic	3.0	0.15	100	0.127	1.0	0.1	0.9	1.35E-01	1.08E-02	1.45E-01	4.9	0.15	45.8	0.127	1.0	0.1	0.9	1.53E-01	4.95E-03	1.58E-01
Barium	187	2.3	26.0	0.951	1.0	0.1	0.9	1.54E+01	2.81E-03	1.54E+01	79.4	2.2	21.3	0.951	1.0	0.1	0.9	7.37E+00	2.30E-03	7.37E+00
Beryllium	1.6	0.005	5.0	0.13	1.0	0.1	0.9	1.97E-02	5.41E-04	2.02E-02	0.75	0.01	4.1	0.13	1.0	0.1	0.9	1.11E-02	4.44E-04	1.15E-02
Cadmium	1.5	0.04	2.5	3.07	1.0	0.1	0.9	3.86E-01	2.70E-04	3.86E-01	0.53	0.03	2.1	3.07	1.0	0.1	0.9	1.44E-01	2.25E-04	1.44E-01
Chromium	37	0.40	1.3	0.588	1.0	0.1	0.9	1.97E+00	1.41E-04	1.97E+00	20.9	0.33	3.8	0.588	1.0	0.1	0.9	1.19E+00	4.11E-04	1.19E+00
Cobalt	4.5	0.02	0.24	0.94	1.0	0.1	0.9	3.42E-01	2.59E-05	3.43E-01	2.8	0.02	2.0	0.73	1.0	0.1	0.9	1.69E-01	2.13E-04	1.69E-01
Copper	4.5	2.1	1.1	1.77	0.53	0.1	0.9	1.11E+00	1.19E-04	1.11E+00	3.2	1.2	2.7	1.77	0.53	0.1	0.9	6.91E-01	2.92E-04	6.91E-01
Iron	6420	33.5	318	0.072	1.00	0.1	0.9	5.93E+01	3.44E-02	5.94E+01	4383	30.9	166	0.072	1.00	0.1	0.9	4.61E+01	1.80E-02	4.62E+01
Lead	9.6	0.03	0.50	0.066	0.43	0.1	0.9	3.02E-02	5.41E-05	3.02E-02	7.5	0.03	7.2	0.066	0.43	0.1	0.9	2.46E-02	7.74E-04	2.53E-02
Manganese	475	5.5	32.2	0.505	1.0	0.1	0.9	2.25E+01	3.48E-03	2.25E+01	278	5.3	24.1	0.505	1.0	0.1	0.9	1.46E+01	2.61E-03	1.46E+01
Mercury	0.03	0.03	0.05	1.74	1.0	0.1	0.9	2.22E-02	5.41E-06	2.22E-02	0.02	0.02	0.05	1.74	1.0	0.1	0.9	1.83E-02	5.41E-06	1.83E-02
Molybdenum	0.16	0.15	0.20	1.15	1.0	0.1	0.9	1.19E-01	2.16E-05	1.19E-01	0.16	0.15	1.2	1.15	1.0	0.1	0.9	1.19E-01	1.30E-04	1.19E-01
Nickel	11.7	0.20	0.65	1.44	1.0	0.1	0.9	1.45E+00	7.03E-05	1.45E+00	7.8	0.20	1.7	1.51	1.0	0.1	0.9	1.05E+00	1.86E-04	1.05E+00
Selenium	5.0	0.40	1.7	7.11	0.44	0.1	0.9	1.34E+00	1.84E-04	1.34E+00	1.81	0.40	0.37	2.57	0.44	0.1	0.9	2.82E-01	3.98E-05	2.82E-01
Silver	0.28	0	0.02	0.18	1.0	0.1	0.9	3.92E-03	1.62E-06	3.92E-03	0.76	0	0.58	0.18	1.0	0.1	0.9	1.06E-02	6.30E-05	1.07E-02
Strontium	198	0	197	1.00	1.0	0.1	0.9	1.54E+01	2.13E-02	1.54E+01	198	0	133	1	1.0	0.1	0.9	1.54E+01	1.44E-02	1.54E+01
Thallium	17.5	0.02	2.6	0.71	1.0	0.1	0.9	9.76E-01	2.76E-04	9.76E-01	9.1	0.02	0.41	0.71	1.0	0.1	0.9	5.10E-01	4.42E-05	5.10E-01
Vanadium	38.0	0.10	0.91	1.10	1.0	0.1	0.9	3.30E+00	9.84E-05	3.30E+00	20.3	0.10	0.86	0.64	1.0	0.1	0.9	1.09E+00	9.31E-05	1.09E+00
Zinc	33.0	42.5	10.7	2.53	1.0	0.1	0.9	3.62E+01	1.16E-03	3.62E+01	22.2	39.0	4.4	2.49	1.0	0.1	0.9	3.16E+01	4.75E-04	3.16E+01

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the east branch of the Ompompanoosuc River.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
BSAF - Biota-Sediment Accumulation Factor for benthic invertebrates
BAV - Bioavailability Adjustment Factor
* - Aluminum, antimony, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc were not selected as sediment COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration. Silver and Strontium were not analyzed for.
** - Silver and strontium were no analyzed for in fish, value equal to zero.
*** - Beryllium, cadmium, mercury, selenium, and thallium were not selected as surface water COPECs. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit. The CTE value represents the mean concentration.
~ - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} X C_{fish} X DF_i X AUF X BAV / BW$
2 $EDD_{water} = IR_{water} X C_{water} X AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 0.148
IR_{diet} 0.115
IR_{water} 0.016

BSAF Calculations

Cobalt	0.395+(0.121*[sediment])
Selenium	1.422*[sediment]*.40
Vanadium	-1.531+(0.722*LN[sediment])

BSAFs for copper, nickel, and zinc equal the 95% Upper Prediction Limit (UPL) of regression calculated by Bechtel (1998b); calculated according to Appendix A in Bechtel (1998b).

Attachment 5.60
Estimated Daily Doses for Mink at School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)					CTE Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet			Water				Diet			Water	
COPECs	Fish Tissue (mg/kg, wet weight)~	Surface Water (ug/L)	BAV*	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD	Fish Tissue (mg/kg, wet weight)~	Surface Water (ug/L)	BAV*	DF	EDD_{diet}[1]	EDD_{water}[2]	Total EDD
Metals														
Aluminum	12.4	494	1.0	1.0	2.47E+00	4.89E-02	2.52E+00	5.7	395	1.0	1.0	1.13E+00	3.91E-02	1.17E+00
Antimony	0.40	0.67	1.0	1.0	7.98E-02	6.63E-05	7.99E-02	0.12	13.6	1.0	1.0	2.33E-02	1.35E-03	2.46E-02
Arsenic	0.15	0.19	1.0	1.0	2.99E-02	1.88E-05	2.99E-02	0.15	32.5	1.0	1.0	2.99E-02	3.21E-03	3.31E-02
Barium	2.3	18.8	1.0	1.0	4.61E-01	1.86E-03	4.63E-01	1.8	17.4	1.0	1.0	3.56E-01	1.72E-03	3.58E-01
Cadmium	0.07	0.23	0.54	1.0	7.54E-03	2.25E-05	7.56E-03	0.04	0.41	0.54	1.0	4.19E-03	4.04E-05	4.23E-03
Chromium	0.50	2.0	0.09	1.0	8.98E-03	1.96E-04	9.17E-03	0.38	3.0	0.09	1.0	6.78E-03	2.98E-04	7.08E-03
Cobalt	0.11	6.8	1.0	1.0	2.19E-02	6.69E-04	2.26E-02	0.06	4.6	1.0	1.0	1.13E-02	4.52E-04	1.18E-02
Copper	7.9	222	1.0	1.0	1.58E+00	2.19E-02	1.60E+00	4.6	117	1.0	1.0	9.11E-01	1.16E-02	9.23E-01
Iron	46.9	569	1.0	1.0	9.36E+00	5.63E-02	9.41E+00	34.7	414	1.0	1.0	6.93E+00	4.10E-02	6.97E+00
Lead	1.2	2.4	1.0	1.0	2.33E-01	2.38E-04	2.34E-01	0.15	3.8	1.0	1.0	2.95E-02	3.76E-04	2.99E-02
Manganese	4.2	67.0	1.0	1.0	8.44E-01	6.63E-03	8.51E-01	3.6	41.5	1.0	1.0	7.19E-01	4.11E-03	7.23E-01
Mercury (inorganic)	0.02	0.17	0.25	1.0	1.05E-03	1.68E-05	1.06E-03	0.01	0.09	0.25	1.0	6.37E-04	9.17E-06	6.46E-04
Molybdenum	0.15	0.18	1.0	1.0	2.99E-02	1.76E-05	2.99E-02	0.15	1.6	1.0	1.0	2.99E-02	1.61E-04	3.01E-02
Nickel	0.20	3.3	1.0	1.0	3.99E-02	3.31E-04	4.02E-02	0.17	3.1	1.0	1.0	3.44E-02	3.07E-04	3.47E-02
Selenium	0.50	8.5	0.57	1.0	5.69E-02	8.42E-04	5.77E-02	0.41	1.8	0.57	1.0	4.67E-02	1.74E-04	4.69E-02
Silver	0	0.67	1.0	1.0	0.00E+00	6.63E-05	6.63E-05	0	0.97	1.0	1.0	0.00E+00	9.62E-05	9.62E-05
Strontium	0	160	1.0	1.0	0.00E+00	1.58E-02	1.58E-02	0	142	1.0	1.0	0.00E+00	1.41E-02	1.41E-02
Vanadium	0.10	0.53	1.0	1.0	2.00E-02	5.29E-05	2.00E-02	0.10	2.2	1.0	1.0	2.00E-02	2.18E-04	2.02E-02
Zinc	40.9	37.6	1.0	1.0	8.16E+00	3.72E-03	8.16E+00	34.1	23.5	1.0	1.0	6.81E+00	2.32E-03	6.81E+00

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the impacted reach of School House Brook.
mg/kg, wt - milligrams per kilogram, weight wet
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
DF - Dose Fraction of fish
BAV - Bioavailability Adjustment Factor
~ Arsenic and molybdenum were not selected as COPECs in fish, value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
Silver and strontium were not analyzed for in fish, values are zero.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron and strontium was listed, 100% bioavailability was assumed.
Equations
1 $Dose_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $Dose_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 $Total\ Dose = Dose_{diet} + Dose_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 1.0
IR_{diet} 0.1995
IR_{water} 0.099

Attachment 5.61
Estimated Daily Doses for Mink at the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration: Fish Tissue (mg/kg, wet weight)**	RME Exposure Point Concentration: Surface Water (ug/L)~	EDD (mg/kg bw-day) Diet: BAV*	EDD Diet: DF	EDD Diet: $Dose_{diet}$ [1]	EDD Water: $Dose_{water}$ [2]	Total EDD	CTE Exposure Point Concentration: Fish Tissue (mg/kg, wet weight)	CTE Exposure Point Concentration: Surface Water (ug/L)~	EDD (mg/kg bw-day) Diet: BAV*	EDD Diet: DF	EDD Diet: EDD_{diet} [1]	EDD Water: EDD_{water} [2]	Total EDD
Metals														
Aluminum	26.5	599	1.0	1.0	5.29E+00	5.93E-02	5.35E+00	9.3	183	1.0	1.0	1.86E+00	1.81E-02	1.88E+00
Antimony	0.05	0.10	1.0	1.0	9.98E-03	9.90E-06	9.98E-03	0.05	11.3	1.0	1.0	9.98E-03	1.12E-03	1.11E-02
Arsenic	0.15	0.18	1.0	1.0	2.99E-02	1.78E-05	2.99E-02	0.15	31.7	1.0	1.0	2.99E-02	3.14E-03	3.31E-02
Barium	1.1	19.5	1.0	1.0	2.25E-01	1.93E-03	2.27E-01	0.58	16.6	1.0	1.0	1.16E-01	1.64E-03	1.18E-01
Cadmium	0.08	0.02	0.54	1.0	8.62E-03	1.98E-06	8.62E-03	0.05	1.1	0.54	1.0	5.23E-03	1.08E-04	5.34E-03
Chromium	0.60	3.0	0.09	1.0	1.08E-02	2.97E-04	1.11E-02	0.46	2.7	0.09	1.0	8.21E-03	2.66E-04	8.47E-03
Cobalt	0.06	0.50	1.0	1.0	1.20E-02	4.95E-05	1.20E-02	0.04	1.3	1.0	1.0	8.55E-03	1.29E-04	8.68E-03
Copper	1.9	1.3	1.0	1.0	3.79E-01	1.26E-04	3.79E-01	1.4	1.6	1.0	1.0	2.88E-01	1.54E-04	2.88E-01
Iron	0.02	726	1.0	1.0	3.59E-03	7.19E-02	7.55E-02	0.01	163	1.0	2.0	4.05E-03	1.61E-02	2.01E-02
Lead	60.5	0.82	1.0	1.0	1.21E+01	8.12E-05	1.21E+01	38.6	6.0	1.0	1.0	7.70E+00	5.93E-04	7.70E+00
Manganese	6.10	28.1	1.0	1.0	1.22E+00	2.78E-03	1.22E+00	3.81	16.3	1.0	1.0	7.61E-01	1.61E-03	7.62E-01
Mercury	0.06	0.10	0.25	1.0	2.99E-03	9.90E-06	3.00E-03	0.04	0.07	0.25	1.0	1.78E-03	7.07E-06	1.79E-03
Molybdenum	0.15	0.34	1.0	1.0	2.99E-02	3.37E-05	3.00E-02	0.15	1.2	1.0	1.0	2.99E-02	1.15E-04	3.00E-02
Nickel	0.20	0.76	1.0	1.0	3.99E-02	7.53E-05	4.00E-02	0.14	1.3	1.0	1.0	2.85E-02	1.33E-04	2.86E-02
Selenium	0.70	1.7	0.57	1.0	7.96E-02	1.68E-04	7.98E-02	0.56	0.51	0.57	1.0	6.34E-02	5.09E-05	6.34E-02
Silver	0	2.5	1.0	1.0	0.00E+00	2.48E-04	2.48E-04	0	0.44	1.0	1.0	0.00E+00	4.32E-05	4.32E-05
Strontium	0	169	1.0	1.0	0.00E+00	1.67E-02	1.67E-02	0	139	1.0	1.0	0.00E+00	1.37E-02	1.37E-02
Vanadium	0.20	0.57	1.0	1.0	3.99E-02	5.68E-05	4.00E-02	0.14	0.92	1.0	1.0	2.85E-02	9.13E-05	2.86E-02
Zinc	33.9	24.3	1.0	1.0	6.76E+00	2.40E-03	6.77E+00	24.4	7.3	1.0	1.0	4.87E+00	7.23E-04	4.87E+00

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the impacted reach of School House Brook.
mg/kg, wt - milligrams per kilogram, weight wet
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction of fish
** - Antimony, arsenic, and molybdenum were not selected as COPECs in fish. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron was listed, 100% bioavailability was assumed.
~ - Mercury and selenium were not selected as COPECs in surface water. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.

Equations
1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF	1.0
Body Weight (BW)	1.0
IR_{diet}	0.1995
IR_{water}	0.099

Attachment 5.62
Estimated Daily Doses for Mink at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

	RME Exposure Point Concentration		EDD (mg/kg bw-day)					CTE Exposure Point Concentration		EDD (mg/kg bw-day)				
			Diet			Water				Diet			Water	
COPECs	Fish Tissue (mg/kg, wet weight)~	Surface Water (ug/L)	BAV*	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD	Fish Tissue (mg/kg, wet weight)~	Surface Water (ug/L)	BAV*	DF	EDD_{diet} [1]	EDD_{water} [2]	Total EDD
Metals														
Aluminum	16.8	380	1.0	1.0	3.35E+00	3.76E-02	3.39E+00	7.1	172	1.0	1.0	1.42E+00	1.70E-02	1.44E+00
Antimony	0.05	0.76	1.0	1.0	9.98E-03	7.52E-05	1.01E-02	0.05	10.4	1.0	1.0	9.98E-03	1.03E-03	1.10E-02
Arsenic	0.15	0.20	1.0	1.0	2.99E-02	1.98E-05	2.99E-02	0.15	25.5	1.0	1.0	2.99E-02	2.53E-03	3.25E-02
Barium	2.4	19.4	1.0	1.0	4.77E-01	1.92E-03	4.79E-01	1.7	19.9	1.0	1.0	3.34E-01	1.97E-03	3.36E-01
Cadmium	0.07	0.09	0.54	1.0	7.54E-03	8.81E-06	7.55E-03	0.04	1.0	0.54	1.0	4.58E-03	9.49E-05	4.67E-03
Chromium	0.30	1.2	0.09	1.0	5.39E-03	1.19E-04	5.51E-03	0.27	3.0	0.09	1.0	4.83E-03	2.99E-04	5.12E-03
Cobalt	0.09	0.67	1.0	1.0	1.80E-02	6.66E-05	1.80E-02	0.07	3.5	1.0	1.0	1.35E-02	3.46E-04	1.38E-02
Copper	3.5	23.9	1.0	1.0	6.98E-01	2.37E-03	7.01E-01	2.1	13.3	1.0	1.0	4.16E-01	1.32E-03	4.18E-01
Iron	50.8	332	1.0	1.0	1.01E+01	3.28E-02	1.02E+01	32.4	196	1.0	1.0	6.45E+00	1.94E-02	6.47E+00
Lead	0.04	0.43	1.0	1.0	7.98E-03	4.25E-05	8.02E-03	0.02	4.5	1.0	1.0	4.11E-03	4.42E-04	4.56E-03
Manganese	6.4	34.3	1.0	1.0	1.28E+00	3.40E-03	1.29E+00	4.6	28.8	1.0	1.0	9.27E-01	2.85E-03	9.30E-01
Mercury	0.02	0.20	0.25	1.0	1.10E-03	1.98E-05	1.12E-03	0.01	0.10	0.25	1.0	7.36E-04	9.63E-06	7.45E-04
Molybdenum	0.15	0.17	1.0	1.0	2.99E-02	1.71E-05	2.99E-02	0.15	1.2	1.0	1.0	2.99E-02	1.15E-04	3.00E-02
Nickel	0.20	1.49	1.0	1.0	3.99E-02	1.48E-04	4.00E-02	0.14	3.6	1.0	1.0	2.87E-02	3.53E-04	2.90E-02
Selenium	0.50	5.8	0.57	1.0	5.69E-02	5.74E-04	5.74E-02	0.36	1.9	0.57	1.0	4.12E-02	1.91E-04	4.14E-02
Strontium	0	149	1.0	1.0	0.00E+00	1.48E-02	1.48E-02	0	129	1.0	1.0	0.00E+00	1.28E-02	1.28E-02
Vanadium	0.10	0.91	1.0	1.0	2.00E-02	9.01E-05	2.00E-02	0.10	3.9	1.0	1.0	2.00E-02	3.87E-04	2.03E-02
Zinc	41.6	629	1.0	1.0	8.30E+00	6.23E-02	8.36E+00	33.6	93.7	1.0	1.0	6.71E+00	9.28E-03	6.72E+00

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the east branch of the Ompompanoosuc River.
mg/kg, wt - milligrams per kilogram, weight wet
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
EBOR - East Branch of the Ompompanoosuc River
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction of fish
BAV - Bioavailability Adjustment Factor
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.
~ Antimony, arsenic, molybdenum, and vanadium were not selected as COPECs in fish. The RME value represents the maximum detected concentration or if not detected one half of the maximum non-detect detection limit.
The CTE value represents the mean concentration.
Strontium was not analyzed for in fish tissue, value is zero.
Equations
1 $EDD_{diet} = IR_{diet} X C_{fish} X DF_i X AUF X BAV / BW$
2 $EDD_{water} = IR_{water} X C_{water} X AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 1.0
IR_{diet} 0.1995
IR_{water} 0.099

Attachment 5.63
Estimated Daily Dose for Mink at the Upstream Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Exposure Point Concentration: Fish Tissue (mg/kg, wet weight)**	RME Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BAV*	Diet: DF	Diet: $Dose_{diet}$[1]	Water: $Dose_{water}$[2]	Total EDD	CTE Exposure Point Concentration: Fish Tissue (mg/kg, wet weight)	CTE Exposure Point Concentration: Surface Water (ug/L)	EDD (mg/kg bw-day) Diet: BAV*	Diet: DF	Diet: EDD_{diet}[1]	Water: EDD_{water}[2]	Total EDD
Metals														
Aluminum	8.9	357	1.0	1.0	1.78E+00	3.54E-02	1.81E+00	6.4	178	1.0	1.0	1.27E+00	1.76E-02	1.29E+00
Antimony	0.10	0.07	1.0	1.0	2.00E-02	6.44E-06	2.00E-02	0.07	9.4	1.0	1.0	1.33E-02	9.26E-04	1.42E-02
Arsenic	0.15	100	1.0	1.0	2.99E-02	9.90E-03	3.98E-02	0.15	45.8	1.0	1.0	2.99E-02	4.53E-03	3.45E-02
Barium	2.3	26.0	1.0	1.0	4.63E-01	2.57E-03	4.65E-01	2.2	21.3	1.0	1.0	4.30E-01	2.11E-03	4.32E-01
Cadmium	0.04	2.5	0.54	1.0	4.31E-03	2.48E-04	4.56E-03	0.03	2.1	0.54	1.0	2.87E-03	2.06E-04	3.08E-03
Chromium	0.40	1.3	0.09	1.0	7.18E-03	1.29E-04	7.31E-03	0.33	3.8	0.09	1.0	5.99E-03	3.76E-04	6.36E-03
Cobalt	0.02	0.24	1.0	1.0	3.99E-03	2.38E-05	4.01E-03	0.02	2.0	1.0	1.0	3.33E-03	1.95E-04	3.52E-03
Copper	2.1	1.1	1.0	1.0	4.19E-01	1.09E-04	4.19E-01	1.2	2.7	1.0	1.0	2.46E-01	2.67E-04	2.46E-01
Iron	33.5	318	1.0	1.0	6.68E+00	3.15E-02	6.71E+00	30.9	166	1.0	1.0	6.16E+00	1.65E-02	6.18E+00
Lead	0.03	0.50	1.0	1.0	5.99E-03	4.95E-05	6.03E-03	0.03	7.2	1.0	1.0	5.32E-03	7.08E-04	6.03E-03
Manganese	5.5	32.2	1.0	1.0	1.10E+00	3.18E-03	1.10E+00	5.3	24.1	1.0	1.0	1.05E+00	2.39E-03	1.06E+00
Mercury	0.03	0.05	0.25	1.0	1.30E-03	4.95E-06	1.30E-03	0.02	0.05	0.25	1.0	1.11E-03	4.95E-06	1.12E-03
Molybdenum	0.15	0.20	1.0	1.0	2.99E-02	1.98E-05	2.99E-02	0.15	1.2	1.0	1.0	2.99E-02	1.19E-04	3.00E-02
Nickel	0.20	0.65	1.0	1.0	3.99E-02	6.44E-05	4.00E-02	0.20	1.7	1.0	1.0	3.99E-02	1.70E-04	4.01E-02
Selenium	0.40	1.7	0.57	1.0	4.55E-02	1.68E-04	4.57E-02	0.40	0.37	0.57	1.0	4.55E-02	3.65E-05	4.55E-02
Strontium	0	197	1.0	1.0	0.00E+00	1.95E-02	1.95E-02	0	133	1.0	1.0	0.00E+00	1.32E-02	1.32E-02
Vanadium	0.10	0.91	1.0	1.0	2.00E-02	9.01E-05	2.00E-02	0.10	0.86	1.0	1.0	2.00E-02	8.52E-05	2.00E-02
Zinc	42.5	10.7	1.0	1.0	8.48E+00	1.06E-03	8.48E+00	39.0	4.4	1.0	1.0	7.78E+00	4.35E-04	7.78E+00

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the east branch of the Ompompanoosuc River.
mg/kg, wt - milligrams per kilogram, weight wet
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
DF - Dose Fraction of fish
BAV - Bioavailability Adjustment Factor
**- Strontium was not analyzed for in fish, value is zero.
* - Source: Section 1.0 (mammals) and Section 2.0 (Birds) in Appendix S of the Elizabeth Copper Mine BERA (URS, 2006). No value for iron or strontium was listed, 100% bioavailability was assumed.

Equations

1 $EDD_{diet} = IR_{diet} \times C_{fish} \times DF_i \times AUF \times BAV / BW$
2 $EDD_{water} = IR_{water} \times C_{water} \times AUF / BW$
3 Total $EDD = EDD_{diet} + EDD_{water}$

Area Use Factor (AUF) 1.0
Body Weight (BW) 1.0
IR_{diet} 0.1995
IR_{water} 0.099

SECTION 6.0: EFFECTS ANALYSIS

6.1 INTRODUCTION

The effects analysis is a qualitative and quantitative evaluation of the toxicity of the COPECs to the receptor groups of concern. The effects analysis for the aquatic portion of the Ely Copper Mine BERA consisted of the following three major components:

Toxicity-based benchmarks:

- sediment benchmarks
- surface water benchmarks
- CBRs for salmonids
- TRVs for birds and mammals

Toxicity testing:

- whole sediment toxicity testing using the amphipod *H. azteca* (28-day exposures) and the larvae of the midge fly *C. tentans* (10-day exposures)
- 96-hour acute toxicity testing of sediment pore water samples using *C. tentans* and *H. azteca*
- seven-day chronic toxicity testing of surface water samples using *P. promelas* (fathead minnow)
- *in-situ* toxicity testing at the on-site ponds using eggs and tadpoles of the wood frog (*Rana sylvatica*)

Field community surveys:

- benthic surveys
- fish surveys

6.2 TOXICITY-BASED BENCHMARKS

6.2.1 Sediment benchmarks

No effect and effect sediment benchmarks are used to assess the potential for ecological risk from exposure to contaminated substrate. The no effect sediment benchmarks are those used to select COPECs in the SLERA (see **Appendix 6**). The published sources of effects sediment benchmarks used in the evaluation are described below. This list is expanded from the one presented in the Elizabeth Copper Mine BERA (URS, 2006) by including effects benchmarks developed by Long et al. (1995) and Persaud et al. (1993) in order to complement the existing values. The order of preference (from highest preference to lowest preference) for selecting the effect sediment benchmarks is as follows:

- The Probable Effect Concentrations (PECs) (McDonald et al., 2000)

- The Effects Range – Median (ER-Ms) (Long et al., 1995)

- Severe Effect Levels (SELs) Ontario Provincial Sediment Quality Guidelines (Persaud et al., 1993).

The consensus-based PECs represent contaminant levels at which harmful effects in benthic invertebrates are likely to be observed. The ER-Ms represent contaminant levels in sediment at which the incidence of effects are likely to be observed. Finally, the SELs represent contaminant levels at which the sediment is considered heavily polluted and likely to affect the health of sediment-dwelling organisms.

Attachment 6.1 presents all of the available effect sediment benchmarks for metals. The shaded values were retained for use in the BERA. **Exhibit 6.1** summarizes the COPEC-specific no effect and effect sediment benchmarks used in the risk characterization.

Exhibit 6.1: No effect and effect sediment benchmarks (mg/kg, dw)		
COPEC	**No Effect**	**Effect**
Aluminum	25,500	NA
Antimony	12	NA
Arsenic	9.79	33
Barium	0.7	NA
Beryllium	NA	NA
Cadmium	0.99	4.98
Chromium	43.4	111
Cobalt	50	NA
Copper	31.6	149
Cyanide	0.0001	NA
Iron	--[a]	40,000
Lead	35.8	128
Manganese	630	1,100
Mercury (inorganic)	0.17	1.06
Mercury (organic)	0.00001	NA
Molybdenum	NA	NA
Nickel	22.7	48.6
Selenium	0.29	NA
Silver	0.5	3.7
Strontium	NA	NA
Thallium	NA	NA
Tin	5.0	NA
Vanadium	50	NA
Zinc	121	459

NA = not available
[a] the no effect benchmark for Fe equals188,400 mg/kg (dw), which exceeds the effect benchmark for this analyte by a factor of four. The lower effect benchmark is retained in order to make the assessment conservative

6.2.2 Surface Water Benchmarks

Acute and chronic surface water benchmarks were used to assess the potential for ecological risk from exposure to surface water. The chronic benchmarks were the ones used for selecting COPECs in the SLERA (see **Appendix 6**). The published sources used to select acute surface water benchmarks were as follows:

- Acute freshwater NRWQCs (USEPA, 2006)

- Maximum Allowable Concentrations (MACs) (State of Vermont, 2006)

- Secondary Acute Values (SAVs) by Suter and Tsao (1996)

Both the acute NRWQCs and MACs represent the highest concentration of dissolved metals to which aquatic life can be exposed for a short period of time (one-hour average) once every three years without deleterious effects. The SAVs have been calculated based on the same general methodology developed for the acute NRWQC, except for using less complete toxicity data sets.

Attachment 6.2 presents the acute (effect) surface water benchmarks for metals. The shaded values were used in the BERA. The toxicity values for the hardness-dependent metals (i.e., Cd, Cr, Cu, Pb, Ni, Si [MAC only], and Zn) were standardized to 100 mg/L hardness. **Exhibit 6.2** summarizes the COPEC-specific no effect and effect surface water benchmarks.

Exhibit 6.2: Acute and chronic surface water benchmarks (µg/L)

Analyte	Acute	Chronic
Aluminum	750	87
Antimony	180	80
Arsenic	340	150
Barium	110	--[a]
Beryllium	35	3.6
Cadmium	2.0	0.25
Chromium[b]	16	11
Cobalt	1,500	24
Copper	13	9.0
Cyanide	22	5.2
Iron	NA	1,000
Lead	65	2.5
Manganese	2,300	120
Mercury (inorganic)	1.4	0.77
Mercury (organic)	0.099	0.00246
Molybdenum	16,000	370
Nickel	470	52
Selenium	20	5.0
Silver	3.2	0.32
Strontium	15,000	1,500
Thallium	110	40
Tin	2,700	180
Vanadium	280	12
Zinc	120	120

NA = not available
[a] the no effect benchmark for Ba equals 220 µg/L, which exceeds the effect benchmark for this analyte by a factor of two. The lower effect benchmark is retained in order to make the assessment conservative

[b] the benchmarks are for Cr(VI) which is substantially more toxic than Cr(III)
NA = not available

6.2.3 Critical Body Residues

CBRs represent conservative tissue concentrations in test organisms at which a particular response (or lack of response) has been reported following exposure to single contaminants. The CBRs (mg/kg ww) used in the Ely Mine BERA were derived from published literature data. These CBRs represent tissue residue data for salmonid species because brook trout (*Salvelinus fontinalis*) and juvenile Atlantic salmon (*Salmo salar*) are two critical fish species present in the waterways affected by the Site.

Appendix 7 describes the process used for developing the no effect and effect fish CBRs. **Exhibit 6.3** presents the final CBRs used in the BERA. CBRs were developed for each inorganic compound detected in at least one of the fish tissue samples collected from the waterways affected by the Site. CBRs were not developed if an inorganic compound was not detected in any of the fish tissue samples. Published fish residue data to develop CBRs for Barium (Ba), Beryllium (Be), Cobalt (Co), Iron (Fe), Manganese (Mn), Ag, and Thallium (Th) were not available. These metals, if present above their DLs in the field-collected whole fish samples, were treated as uncertainties in the risk characterization of the BERA.

Exhibit 6.3: Whole body CBRs for salmonids

Chemical	Critical Body Residues (mg/kg, ww)	
	No effect	Effect
Aluminum	4.2	13.5
Antimony	5.0	9.0
Arsenic	1.8	4.2
Barium	NA	NA
Beryllium	NA	NA
Cadmium	0.10	0.29
Chromium	0.58	NA
Cobalt	NA	NA
Copper	--[a]	2.4
Iron	NA	NA
Lead	3.8	4.0
Manganese	NA	NA
Mercury (inorganic)	--[b]	0.73
Mercury (organic)	--[c]	4.3
Nickel	0.82	NA
Selenium	0.37	0.76
Silver	NA	NA
Thallium	NA	NA
Vanadium	0.02	0.41
Zinc	16.4	NA

NA = no data available

[a] the no effect CBR for Cu (3.1 mg/kg ww) exceeded its effect CBR (2.4 mg/kg ww). Only the effect CBR will be used in the BERA.
[b] the no effect CBR for inorganic Hg (0.84 mg/kg ww) exceeded its effect CBR (0.73 mg/kg ww). Only the effect CBR will be used in the BERA.
[c] the no effect CBR for organic Hg (7.0 mg/kg ww) exceeded its effect CBR (4.3 mg/kg ww). Only the effect CBR will be used in the BERA.

6.2.4 Toxicity reference values for wildlife receptors

The Elizabeth Copper Mine BERA (URS, 2006) developed COPEC-specific No Observed Adverse Effect Level (NOAEL) TRVs (i.e., no effect TRVs) and Lowest Observed Adverse Effect Level (LOAEL) TRVs (i.e., effect TRVs) for birds and mammals. This reference should be consulted for details on the studies that were evaluated and the TRV selection process. **Exhibit 6.4** summarizes the final TRVs. These values were used in this BERA to asses the toxicity of COPECs that were modeled to be ingested by wildlife receptors feeding on fish or emerging insects at the waterways affected by the Site.

Exhibit 6.4: No effect and effect TRVs for birds and mammals

Analyte	Bird receptors		Mammal receptors	
	No Effect TRVs[a]	Effect TRVs[a]	No Effect TRVs[a]	Effect TRVs[a]
Aluminum	NA	NA	NA	NA
Antimony	NA	NA	13.3	66.5
Arsenic	5.5	22	5.7	11.6
Barium	208	416	51.8	259
Beryllium	NA	NA	0.53	2.7
Cadmium	1.9	21.1	5.1	7.1
Chromium	37.7	75.4	8.8	44.2
Cobalt	7.61	38.1	7.3	36.7
Copper	33	62	11.7	15.1
Iron	NA	NA	NA	NA
Lead	7.4	37	34	80
Manganese	977	4,885	88	284
Mercury (inorg.)	0.45	0.91	13.2	56
Mercury (org.)	0.14	0.68	0.08	0.12
Molybdenum	7.1	35.3	2.6	13
Nickel	80	107	60	80
Selenium	0.4[a]	0.8[a]	0.35	1.05
Silver	14.5	43.6	44.4	222
Strontium	NA	NA	NA	NA
Thallium	NA	NA	0.2	1.0
Tin	NA	NA	NA	NA
Vanadium	11.38	56.9	5.9	8.3
Zinc	14.5	131	160	320
Cyanide	receptor-specific[b,c]		68.7	343.5

Source: Sections 5.1.3.3 (Birds) and 5.1.3.4 (Mammals), and Table 5-2 (for birds exposed to cyanide) in the Elizabeth Copper Mine BERA (URS, 2006)

all of the values have units of mg COPEC/kg BW/day
NA = not available

[a] The no effect TRV = 1.6 mg Se/kg BW/day and the effect TRV = 3.2 mg Se/kg BW/day for the tree swallow and kingfisher
[b] The no effect TRV = 3.3 mg CN/kg BW/day and the effect TRV = 4.3 mg CN/kg BW/day for the tree swallow
[c] The no effect TRV = 0.52 mg CN/kg BW/day and the effect TRV = 0.68 mg CN/kg BW/day for the king fisher

The bird or mammal TRVs were not scaled to account for differences in body mass between the test species used to derive the TRV and the wildlife ROC used in the BERA. Such an approach was routinely applied in the 1990's, but has been shown to not be supported by the available scientific evidence. The rationale for avoiding body mass scaling is provided in Section 5.1.3.2 in the Elizabeth Copper Mine BERA (URS, 2006).

6.3 TOXICITY TESTING

6.3.1 Bulk sediment toxicity testing

Bulk sediment samples were collected on August 22 and 23, 2006 as follows (see also Figure 1 in **Appendix 8**):

- Three samples from the main stem of Ely Brook (EB2, EB3 and EB4), plus one reference sample in Ely Brook (EB1-ref) collected upstream of potential mining influences.

- Three samples from Schoolhouse Brook (SB3, SB4, and SB5a, and its duplicate - SH5b), plus one reference sample collected above the confluence of Schoolhouse Brook with Ely Brook (SHB1-ref).

- One sample from the EBOR (OR-3) collected less than 0.5 miles downstream of the confluence with Schoolhouse Brook, plus one reference sample collected in the EBOR above the confluence (OR1-ref).

Twenty five to 30 representative subsamples at each sampling location were obtained across the stream channel and composited. The tests took place at the USGS Columbia Environmental Research Center (CERC) in Columbia, MO. The samples were evaluated for toxicity using eight-day old juveniles of the freshwater amphipod, *Hyallela azteca*, and about 10-day old (second instar stage) larvae of the midge insect, *Chironomus dilutus*. The amphipods were exposed for 28 days, whereas the midge larvae were exposed for 10 days. Each sediment sample was also characterized for metal concentrations and other physical and chemical properties (i.e., moisture content, particle size distribution, AVS-SEM, and TOC).

Eight replicates per sediment sample and the laboratory control were prepared for each species. Ten test organisms were introduced in each test beaker. The test was static-renewal, with two daily changes of the overlying water. The organisms were fed daily. The test endpoints were survival and growth (length) for the amphipods and survival and growth (ash-free dry weight) for the midges.

Exhibit 6.5 summarizes the results and the outcome of the statistical analyses detailed in **Appendix 8**.

Exhibit 6.5: Survival and growth in *H. azteca* and *C. dilutus* exposed to bulk sediment										
Ely Brook				**Schoolhouse Brook**					**The EBOR**	
EB1-ref	**EB2**	**EB3**	**EB4**	**SB1-ref**	**SB3**	**SB4**	**SB5a**	**SB5b[a]**	**OR1-ref**	**OR3**
H. azteca (amphipod) survival (%) after 28 days										
93.8	68.8*	6.3*	91.3	93.8	52.5*	64.3*	52.5*	68.8*	93.8	91.3
H. azteca (amphipod) growth (mg) after 28 days										
3.24	2.45*	1.96*	3.39	3.31	2.43*	2.53*	2.55*	2.48*	3.21	3.17
C. dilutus (midge) survival (%) after 10 days										
63.8	61.3	65	72.5	76.3	80	62.5	67.5	83.8	90	83.8
C. dilutus (midge) growth (mg) after 10 days										
0.47	0.37*	0.20*	1.56	0.46	0.26*	0.28*	0.31*	0.49	0.47	0.83

[a] Sample SHB5b is a duplicate of SHB5a
* indicates that the response is significantly different from the reference

The toxicity test results can be summarized as follows:

<u>*H. azteca*</u>

The test met the Test Acceptability Criterion (TAC), with 93.8% survival (minimum required is 80% survival) observed in the laboratory control sample after 28 days of exposure.

- Main stem of Ely Brook

  Survival and growth in two of the three bulk sediment samples decreased significantly compared to the upstream reference sample. Surprisingly, EB4 was not toxic, even though this sample had the highest levels of Cu, both in the bulk sediment phase (5,950 mg/kg) and the filtered pore water phase (2,140 µg/L). These concentrations should have resulted in rapid and complete mortality. The reason for the lack of toxicity was not known. It was suspected that the renewal water (pH of 8.2 and alkalinity equal to 100 mg/L as $CaCO_3$) may have increased the pore water pH in this sample, thereby causing the dissolved metals to precipitate out and become non-bioavailable (see **Appendix 8**).

- Schoolhouse Brook

  Survival and growth in all bulk sediment samples decreased significantly compared to the upstream reference sample. These results indicated that the sediment in the entire portion of Schoolhouse Brook affected by AMD was toxic to amphipods down to the confluence with the EBOR.

- The EBOR

  Survival and growth in the one bulk sediment sample collected from the EBOR below the confluence with Schoolhouse Brook was no different from the upstream reference sample.

C. dilutus

The toxicity test met the TAC, with 86.3% survival (minimum required is 70% survival) observed in the laboratory control sample after 10 days of exposure.

- Main stem of Ely Brook

  Survival in the three bulk sediment samples was not different compared to the upstream reference sample from Ely Brook. One reason for this pattern may be that survival in the reference sample was relatively low (63.8%) and also fell below the TAC. However, growth was significantly lower in two of the three samples. The one exception was again EB4, even though this sample had the highest levels of Cu. The lack of apparent toxicity may have been due to chemical changes caused by the renewal water.

- Schoolhouse Brook

  Survival in all of the sediment samples did not differ significantly compared to the upstream reference sample, whereas growth was significantly reduced. However, growth in the duplicate sample (SB5b) did not differ from the upstream reference sample. Nonetheless, these results indicated that the substrate in the entire portion of Schoolhouse Brook affected by AMD was toxic to midge fly larvae down to the confluence with the EBOR.

- The EBOR

  Survival and growth in the one bulk sediment sample collected from the EBOR below the confluence with Schoolhouse Brook was no different from the upstream reference sample.

In summary, both test species responded negatively when exposed to bulk sediment from the main stem of Ely Brook and the AMD-impacted reach of Schoolhouse Brook. The one sediment sample collected from the EBOR less than 0.5 mile downstream from its confluence with Schoolhouse Brook was non toxic to either species. The toxic responses in the amphipods were stronger than those observed in the midges. One reason may be that the amphipods were exposed for longer (28 days) compared to the midges (10 days).

6.3.2 Sediment pore water toxicity testing

Sediment pore water samples were collected on August 22, 2006 as follows (see also Figure 1 in **Appendix 9**):

- Three samples from the main stem of Ely Brook (EB2, EB3 and EB4).
- One reference sample from Schoolhouse Brook above the confluence with Ely Brook (SB 1 REF).
- Three samples from Schoolhouse Brook between the confluence with Ely Brook and the EBOR (SB3 to SB5).
- One sample from the EBOR downstream from the confluence with Schoolhouse Brook (OMP3).

The pore water was collected using metal push point samplers consisting of an inner portion and an outer portion. The sampler was driven [about 6”] into the sediment at each sampling location. The inner portion of the sampler was then removed, with the outer portion remaining in the substrate. A mini well with a screen was inserted in the push point sampler. A plastic hose was connected to the top of the well and water was gently withdrawn using a syringe at a rate of about 100 mL per minute. The conductivity of the pore water was continuously monitored. The sample aliquots for chemical analyses and toxicity testing were obtained only after the conductivity reading stabilized.

The tests took place at the NERL in North Chelmsford, MA. All of the samples were tested undiluted using 14 to 21 day-old juveniles of the freshwater amphipod, *H. azteca*, and 11- to 12-day old (second-to-third instar larval stage) juveniles of the midge insect, *C. tentans*. All exposures lasted for 96 hours.

Ten replicates of each pore water sample and the laboratory control were prepared for each species to start the test. The test was static, non-renewal. The organisms were fed at 0 and 48 hours. The test endpoints consisted of survival after 96 hours of exposure.

Exhibit 6.6 summarizes the results and the outcome of the statistical analyses detailed in **Appendix 9**).

Exhibit 6.6: Survival in *H. azteca* and *C. tentans* exposed to sediment pore water for 96 hours

reference	Ely Brook[a]			Schoolhouse Brook			EBOR[b]
SB1-ref	EB2	EB3	EB4	SB3	SB4	SB5	OMP3
H. azteca survival (%)							
85%	40%*	10%*	0%*	100%	85%	85%	90%
C. tentans survival (%)							
100%	100%	100%	50%	90%	100%	90%	100%

[a] only the results of the undiluted Ely Brook samples are presented in this table
[b] EBOR = east branch of the Ompompanoosuc River
* indicates that the response is significantly different from the reference

The data can be summarized as follows:

- The *H. azteca* toxicity test met the TAC, with 100% control survival. All three pore water samples collected from Ely Brook were acutely toxic after 96 hours of exposure. Acute pore water toxicity was absent from the three Schoolhouse Brook and the EBOR sampling locations.

- The *C. tentans* toxicity test did not meet the TAC because control survival was only 70%, instead of the minimum-required 90%. However, survival was 100% at the reference location (SB1 ref). No statistically significant differences were found when short-term survival in Ely Brook and Schoolhouse Brook pore water was compared to the survival observed in the pore water reference sample.

In summary, *H. azteca* was by far the most sensitive of the two test species when exposed to sediment pore water for 96 hours. Therefore, only the results of this species were evaluated in the risk characterization. Also, the pore water collected at EB4 was acutely toxic to *H. azteca*, in contrast to the complete lack of toxicity observed after 28 days of exposure to the bulk sediment sample collected at the same location (see **Exhibit 6.5**). This pattern supported the interpretation that the bulk sediment chemistry in sample EB4 was altered by the high pH and relatively hard laboratory water used in the daily renewals.

6.3.3 Surface water toxicity testing

The surface water toxicity testing program consisted of a laboratory component and a field component.

6.3.3.1 Laboratory component

Surface water samples were collected on June 20, 2006 from three locations in Ely Brook and five locations in Schoolhouse Brook, as follows (see Figures 2.a and 2.b in **Appendix 10)**:

- One reference sample from Pond 4 (EMTT-1-ref) located on the east branch of Ely Brook (note: pond 4 was subsequently identified to be impacted by AMD)

- One sample from Pond 5 (EMTT-2) located on the east branch of Ely Brook downstream of Pond 4.

- One sample from the main stem of Ely Brook at the weir (EMTT-3).

- One reference sample from Schoolhouse Brook above the confluence with Ely Brook (EMTT-4-ref).

- Four samples from Schoolhouse Brook between the confluence with Ely Brook and the EBOR (EMTT-5 to EMTT-8).

The seven-day toxicity tests took place at the NERL in North Chelmsford, MA. The surface water samples used in toxicity testing were concurrently analyzed for metals. All samples were tested undiluted for toxicity using neonates (< 24-hrs old) of the fathead minnow (*Pimephales promelas*). Four replicates of each of the surface water samples and the laboratory control were prepared to start the test. 250 mL of test water was added to each 300 mL beaker. The water was renewed daily. In addition, fresh renewal water was collected from the same field locations on June 23, 2006, except for EMTT-2 and EMTT-3 because all of the fish exposed to water from these two locations had died. The test endpoints consisted of survival and growth.

The water flea (*Ceriodaphnia dubia*) was exposed concurrently with the *P. promelas*. Ten replicates of each surface water sample (on-site and reference) and the laboratory control were prepared to start the test. Each replicate consisted of 15 mL of sample added to a 20-mL culture tube. One *C. dubia* neonate was added to each culture tube to start the test. The water was renewed daily. Fresh renewal water was collected from the same field locations on June 23, 2006, except for EMTT-2 and EMTT-3 because all of the *C. dubia* exposed to water from these two locations had died. The test endpoints consisted of survival and reproduction.

The results of the laboratory control were reviewed to evaluate test validity at the end of the seven-day test period. The *P. promelas* test met the quality control specifications. The *C. dubia* test, on the other hand, was invalidated because neither the laboratory control nor the reference samples met the minimum TAC for control survival and reproduction, as specified in the laboratory protocol. Only the fish data discussed below were used in the risk characterization.

Exhibit 6.7 summarizes the results and the outcome of the statistical analyses for the fathead minnow test detailed in **Appendix 10**.

Exhibit 6.7: Survival and growth in fathead minnows exposed to surface water for seven days

Reference	Pond 4	Pond 5	Ely Brook	Schoolhouse Brook			
EMTT-4-ref	**EMTT-1-ref**	**EMTT-2**	**EMTT-3**	**EMTT-5**	**EMTT-6**	**EMTT-7**	**EMTT-8**
SURVIVAL (%)							
92.5%	20%[a]	0%*	0%*	2.5%*	17.5%*	15%*	47.5%*
AVERAGE DRY BIOMASS[b] (mg)							
0.39 mg	0.03 mg[a]	0 mg*	0 mg*	0 mg*	0.03 mg*	0.02 mg*	0.10 mg*

[a] the statistical significance of this data point was not tested because Pond 4 was found to be an unacceptable reference location
[b] average dry biomass = measured dry weight ÷ number of exposed organisms
* indicates that the response is significantly different from the reference

The results indicated that of the two reference samples, only the one collected in Schoolhouse Brook upstream of the confluence with Ely Brook (EMTT-4-ref) was non-toxic to *P. promelas*. The reference sample collected from Pond 4 (EMTT-1-ref) was quite toxic, resulting in only 20% survival.

These data showed that pond 4 did not reflect reference conditions. Likewise, the surface water sample collected from the main stem of Ely Brook at the weir (EMTT-3) was highly toxic, with no survival after less than three days of exposure. Toxicity was also severe in the four samples collected from Schoolhouse Brook below the confluence with Ely Brook. That response extended all the way to the confluence of Schoolhouse Brook with the EBOR (EMTT-8), covering a distance of over 2.0 miles. The average dry biomass reflected the poor survival data.

6.3.3.2 Field component

6.3.3.2.1 Wood frog egg hatching success and initial tadpole survival

In-situ toxicity testing using fertilized eggs of the wood frog (*Rana sylvatica*) was performed in May of 2007 in ponds 1, 4, and 5 located on the east branch of Ely Brook. Previous field observations indicated that all five ponds on the east branch were used extensively for breeding by amphibians during the spring season.

Wood frog egg masses were collected on May 2, 2007 from a nearby off-Site reference pond. The egg masses were divided into clutches of about 20 eggs and combined randomly into test groups of about 100 eggs. The eggs were then transported to the Site, slowly acclimated to the pond water for one hour, and placed in small, floating kitchen strainers located in specially built cages. Four cages (i.e., four replicates) were deployed in the three on-Site ponds and the off-Site reference pond, for a total of 16 cages (see **Appendix 11** for details).

The test recorded egg hatching success and initial tadpole survival after hatching. The experiment ended on May 10, 2007 after almost all of the eggs in the ponds had hatched. The hatching success and tadpole survival data were statistically analyzed to determine significant differences. **Exhibit 6.8** summarizes the results and the outcome of the statistical analyses detailed in **Appendix 11**.

Exhibit 6.8: Hatching success and initial survival in wood frog embryos exposed to pond surface water for eight days

Off-Site reference	Pond 1 (on-Site reference)	Pond 4	Pond 5
HATCHING SUCCESS (%)			
89.7%	87.5%	93.7%	80.9%
INITIAL TADPOLE SURVIVAL (%)			
87.8%	87.5%	93.7%	0.32%*

* indicates that the response is significantly different from the references

The data showed that the hatching success in the three on-Site ponds did not differ significantly from that observed in the off-Site reference pond. However, all but one tadpole died in pond 5 shortly after hatching, whereas tadpole survival in the other two on-Site ponds was unaffected.

The results suggest that the gelatinous eggs protected the developing wood frog embryos from the toxic surface water in pond 5. However, the free-swimming tadpoles died soon after hatching when they were exposed directly to ambient conditions. This pattern mirrored the one observed with the fathead minnow larvae exposed to water from pond 5 in the laboratory where all of the fish died within 24 hours of the start of the exposure.

The short-term exposure of the free-swimming tadpoles in pond 4 did not result in increased mortality. It is not known how long it took the eggs to hatch between their deployment on May 2, 2007 and the end of the experiment on May 10, 2007. However, it was unlikely that free-swimming tadpoles were present for more than a day or two before the experiment was ended on May 10, 2007. Hence, the tadpoles in pond 4 would not have been exposed long enough to the ambient conditions to result in a toxic response. This interpretation was supported by the fact that the fathead minnow larvae exposed to water from pond 4 in the laboratory started dying only after 48 hours.

6.3.3.2.2 Long-term wood frog tadpole survival

A longer-term exposure using fresh tadpoles obtained from the off-Site reference pond was started after the hatching test was completed to track survival, growth, and development of the developing tadpoles for up to four weeks (see **Appendix 12**).

Four floating cages, each containing fifty, one-week old wood frog tadpoles, were deployed on May 16, 2007 in the off-Site reference pond, pond 1 (on-Site reference pond), pond 4, and pond 5. Each pond was visited twice a week. During those visits, the tadpoles were inspected for survival and growth, all cages were scrubbed and rinsed, a filtered surface water sample was collected for dissolved metals analysis, and the surviving tadpoles were fed pre-weighed amounts of fish flakes (Tetramin) and a boiled leaf of romaine lettuce.

The test ended after 24 days due to complete tadpole mortality at the off-Site reference pond and pond 1. It is speculated that the surface water quality was compromised due to excessive feeding and inadequate water circulation in the inner bag. The early trends in the data confirmed that the conditions in Pond 5 were highly toxic to wood frog tadpoles (0% survival after 8 days). The conditions in Pond 4 resulted in 62.5% mortality after 8 days versus 12.5% mortality in the off-site reference pond and 14% in pond 1 (see Table 1 and Figure 1 in **Appendix 12**). The data from pond 4 strongly suggested toxicity but were ultimately inconclusive because survival in the reference ponds also declined steadily to zero after 24 days.

The results from the wood frog egg hatching study were used quantitatively in the risk characterization. Only the data from day 8 (May 24, 2007) from the wood frog tadpole survival study were used qualitatively in the risk characterization due to severe limitations with the data.

Field observations showed that ponds 1, 4, and 5 were used extensively as breeding habitat by the local frog populations (particularly wood frogs and green frogs) and salamander populations (red-spotted newts). Field personnel reported seeing many egg masses along the banks of these three ponds during repeated site visits to check the cages. Tadpoles hatching from natural egg clutches deposited along the shallow edges of pond 5 appeared to die quickly as indicated by the many dead tadpoles seen laying on the substrate next to the egg clutches. This field observation mirrored the mortality pattern seen in the tadpoles held in the cages deployed in pond 5. Dead tadpoles were not observed next to natural egg clutches in pond 4, suggesting that the hatched tadpoles were able to survive long enough to swim away from the egg masses.

6.4 FIELD COMMUNITY SURVEYS

6.4.1 Benthic community surveys

Various locations on Ely Brook (but excluding the ponds on the east branch), Schoolhouse Brook, and the EBOR were occasionally assessed for macroinvertebrate community health since 1987 by the State of Vermont, the USGS, and others (**Appendix 13**). The macroinvertebrate data were collected using standard field sampling protocols developed by the VTDEC. Both riffle and pool habitats were targeted. However, pools were not included in the VTDEC determination of Aquatic Life Uses (ALUs) because they are typically unproductive, do not represent the typical habitat found in these streams, and lack numerical guidelines for data interpretation.

The macroinvertebrate samples were processed and analyzed using standard VTDEC procedures to determine the macroinvertebrate biological condition. All organisms were identified to the lowest-practical taxon, except Oligochaeta (worms) which were identified to family. The counts were used to calculate community metrics which represent different aspect of the structure and function of the benthic community. These site-specific values were then compared to ranges of values observed in minimally disturbed streams of similar size and nature in Vermont.

Each macroinvertebrate sample was evaluated for the following eight metrics:

- *Density* is a general indicator of secondary productivity. It represents the number of organisms in a sample.

- *Species richness* is the total number of distinct taxa in a sample.

- *EPT index* is a subset of species richness. This metric represents the number of species in the less stress tolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddies-flies).

- The *Percent Model Affinity of Orders (PMA-O)* is a measure of order-level similarity to a model based on reference streams. PMA-O is calculated by determining the % composition for each major group – Coleoptera (beetles), Diptera (true flies), Ephemeroptera, Plecoptera, Trichoptera, Oligochaeta, and Other – at the sampling location and comparing this value to the mean % composition values from the reference condition (i.e., the model).

- The *Biotic Index (BI)* measures the tolerance of the macroinvertebrate assemblage to organic (i.e., nutrient) enrichment. This metric is calculated by multiplying the number of organisms in a taxon by its assigned tolerance value. The BI value is the total of all these products divided by the total number of individuals of each taxon assigned a tolerance value.

- The *percent Oligochaete (% Oligo)* measures the % of the assemblage made up of the Order Oligochaeta. This metric is calculated by dividing the number of Oligochaeta by the total number of organisms in the sample.

- The *EPT/EPT & Chironomidae (EPT/EPTC)* represents the ratio of the less stress tolerant mayfly-stonefly-caddisfly orders to the generally more tolerant Chironomida (midges). This metric is calculated by dividing the number of organisms from the orders Ephemeroptera, Trichoptera, and Plecoptera by that total plus the animals of the order Chironomidae from the same sample.

- *The Pinkham-Pearson Coefficient of Similarity – Functional Groups (PPCS-Func.)* measures the functional feeding group similarity to a model based on the reference streams. Even though similar in concept to the PMA-O, it measures functional feeding group changes instead of taxonomic changes. This metric is calculated by first determining the % composition of the six major functional groups (collector gatherer, collector filterer, predator, shredder-detritus, shredder-herbivore, scraper) in the sample. The quotient of minimum/maximum between the sample location and the reference model for the stream category is determined for each functional group. The PPCS-F is the sum of these quotients divided by six (i.e., the number of functional groups)

The results of the benthic community surveys conducted at the Site are summarized below by stream.

6.4.1.1 Main stem of Ely Brook

Four locations were investigated for benthic invertebrate community health in 1987 and 2006: one reference location in the upper reach of Ely Brook (River Mile [RM] 0.9) and three locations in the main stem of Ely Brook (RM 0.7; RM 0.4; and RM 0.1).

The upstream reference location was classified as *very good – good*. It supported the Vermont Class B ALUs macroinvertebrate biocriteria guidelines for Small High-Gradient (SHG) streams.

The three locations in the main stem of Ely Brook further downstream were all classified as *poor*, non-supporting of Vermont Class B ALUs macroinvertebrate biocriteria guidelines for SHG streams. Severe stress in the benthic invertebrate community was observed in the entire reach of the main stem of Ely Brook affected by AMD.

6.4.1.2 Schoolhouse Brook

Seven locations were investigated for benthic invertebrate community health in 1987, 1997, 2001, or 2006: two reference locations (RM 2.3 and RM 2.4) upstream of the confluence of Ely Brook with Schoolhouse Brook and five locations on Schoolhouse Brook below Ely Brook (RM 2.2 [just below the confluence with Ely Brook], RM 1.7, RM 1.0, RM 0.4, and RM 0.2 [just above the confluence with the EBOR]) .

The two upstream reference locations were classified as *excellent* to *good*, and supporting of Vermont Class B ALUs macroinvertebrate biocriteria guidelines for SHG streams.

The five locations further downstream were all classified as *poor*, non-supporting of Vermont Class B ALUs macroinvertebrate biocriteria guidelines for SHG streams. Severe stress in the benthic invertebrate community was observed in the entire reach of Schoolhouse Brook affected by AMD.

6.4.1.3 The EBOR

Four locations were investigated for benthic community health in 2005 or 2006: one reference location (RM 16.1) upstream of where Schoolhouse Brook joins the EBOR and three locations further downstream on the EBOR (RM 15.9 [just below the confluence with Schoolhouse Brook], RM 15.6, and RM 7.3.

The upstream reference location was classified as *excellent – very good*. The three locations below the confluence with Schoolhouse Brook were classified as *good* and *very good*. As a result, all four locations on the EBOR supported Vermont Class B ALUs macroinvertebrate biocriteria guidelines for Medium High-Gradient (MHG) streams. No stress associated with AMD was observed in the benthic invertebrate community.

6.4.2 <u>Fish community surveys</u>

Various locations on Schoolhouse Brook and the EBOR were assessed occasionally for fish community health since 1987 by the State of Vermont, the United States Geological Survey (USGS), and others (**Appendix 13**).

The fish data were obtained using standard field sampling protocols developed by the VTDEC. The field data were converted to Indices of Biotic Integrity (IBIs) which are comprised of multiple measures of fish assemblage structure, function, and condition. These values are combined to provide a single numeric index which represents the overall biological integrity of the fish assemblage at each sampling location.

The interpretation of this index varies depending on the size and type of stream. Most of Schoolhouse Brook, up to about 0.5 mile from its confluence with the EBOR, was evaluated under the Cold Water Index of Biotic Integrity (CWIBI). The lower end of Schoolhouse Brook and all of the EBOR was evaluated under the Mixed Water Index of Biotic Integrity (MWIBI).

The CWIBIs were derived from the following seven fish metrics collected at each sampling location:

- Total number of fish per 100 m^2 (total #/100 m^2).

- Number of native intolerant species.
- Proportion of fish classified as cold water fish (cold water spp %).
- Proportion of fish representing generalist feeders (general feeder %)
- Proportion of fish representing top carnivores (top carnivore %)
- Number of brook trout per 100 m^2
- Brook trout age class structure

The MWIBIs were derived from the following nine fish metrics collected at each sampling location:

- Total number of native fish species (richness)
- Number and identity of native, intolerant fish species (No. intol. species)
- Number and identity of native benthic insectivorous species (No. benthic insect. species)
- Proportion of fish as white suckers and creek chubs (creek chub & white sucker %)
- Proportion of fish as generalist feeders (gen. feeder %)
- Proportion of fish as water column insectivores and benthic insectivores (insectivore %)
- Proportion of fish as top carnivores (top carnivore &)
- Proportion of fish with deformities, fin erosion, lesions, or tumors (anomalies %)
- Number of fish per 100 m^2 (total/100 m^2)

Appendix 13 provides the results of the fish surveys performed on Schoolhouse Brook and the EBOR. The assessments are summarized below.

6.4.2.1 Schoolhouse Brook

Seven locations were investigated for fish community health in 1988, 1997, 2000, 2001, or 2006: two reference locations (RM 2.3 and 2.4) upstream of where Ely Brook joins Schoolhouse Brook and five locations on Schoolhouse Brook below Ely Brook (RM 2.2 [just below the confluence with Ely Brook], RM 1.7, RM 1.0, RM 0.4, and RM 0.2 [just above the confluence with the EBOR]) .

The fish community at the two upstream reference locations was classified as *excellent* to *good*, based on the CWIBI.

The five locations downstream of the confluence with Ely Brook were all classified as *poor*, based on the CWIBI (RM 2.2, RM 1.7, and RM 1.0) and the MWIBI (RM 0.4 and RM 0.2). Severe stress to the fish community was observed in the entire reach of Schoolhouse Brook affected by AMD.

6.4.2.2 The EBOR

Five locations were investigated for fish community health in 2001, 2002, 2006 or 2007: one reference location (RM 16.1) upstream of where Schoolhouse Brook joins the EBOR and four locations further downstream on the EBOR (RM 15.9 [just below the confluence with Schoolhouse Brook], RM 15.6, RM 13.8 and RM 10.1.

The upstream reference location was classified as *good* (2006) to *very good* (2001), based on the MWIBI.

Two of the four downstream locations were classified as *good* (RM 15.9 [2006] and RM 10.1 [2001]) based on the MWIBI, the third downstream location was classified as *poor* (RM 13.8 [2002]), and the last downstream locations (RM 15.6) was classified as both *good* (2007) and *poor* (2006). The results of the fish surveys on the EBOR, though not as conclusive as the benthic community surveys on the same general stretch of river, did not indicate a systematic impact from AMD. The reason is that the *poor* ratings were obtained at two locations further <u>downstream</u> of the location closest to the confluence of Schoolhouse Brook (i.e., RM 15.9), which itself showed a rating of *good*. One would expect the fish community at RM 15.9 to be at least as degraded as locations further downstream if AMD was responsible for the observed pattern. Also, the fact that the MWIBI score at RM 15.6 went from *poor* in 2006 to *good* in 2007 may suggest the potential for a sampling bias. It is concluded that stress associated with AMD was not likely observed in the fish community at the EBOR, although this conclusion was not as definitive as for the benthic invertebrate community in the same waterway.

Attachment 6.1: Median to Severe Effects Sediment Benchmarks			
Benchmark Type	Consensus-Based Probable Effect Concentration (PEC)	Effects Range - Median (ER-M)	Severe Effect Level (SEL)
Reference	(MacDonald et al., 2000)	(Long et al., 1995)	(Persaud et al., 1993)
ORDER OF PREFERENCE	*1*	*2*	*3*
Inorganics (mg/kg, DW)			
Aluminum			
Antimony			
Arsenic (III)	33	70	33
Arsenic (V)			
Barium			
Beryllium			
Cadmium	4.98	9.6	10
Chromium (total)	111	370	110
Chromium (VI)			
Cobalt			
Copper	149	270	110
Cyanide			
Iron			40,000
Lead	128	218	250
Manganese			1,100
Mercury (inorganic)	1.06	0.71	2
Mercury (organic)			
Molybdenum			
Nickel	48.6	51.6	75
Selenium			
Silver		3.7	
Strontium			
Thallium			
Tin			
Vanadium			
Zinc	459	410	820

Data sources for the freshwater sediment benchmarks:

1. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

2. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.

3. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

the shaded values were used as effect sediment benchmarks

Attachment 6.2: Acute benchmarks for Surface water			
Benchmark Type	National Acute Water Quality Criteria	Maximum Allowable Conc. (MAC)	Secondary Acute Values (SAV)
Reference	USEPA (2006)	State of Vermont (2006)	Suter and Tsao (1996)
Preference	***1***	***2***	***3***
Inorganics (ug/L)			
Aluminum	750		
Antimony			180
Arsenic	340	360	
Barium			110
Beryllium			35
Cadmium	2	3.9	
Chromium (III)	570	1,737	
Chromium (VI)	16	16	
Cobalt			1,500
Copper	13	17.7	
Cyanide	22	22	
Iron			
Lead	65	81.6	
Manganese			2,300
Mercury (inorganic)	1.4	2.4	
Mercury (organic)			0.099
Molybdenum			16,000
Nickel	470	1,418	
Selenium		20	
Silver	3.2	4.1	
Strontium			15,000
Thallium			110
Tin			2,700
Vanadium			280
Zinc	120	117	

Data sources for the freshwater benchmarks are as follows:

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

the shaded values were used as the acute surface water benchmarks

SECTION 7.0: RISK CHARACTERIZATION

7.1 INTRODUCTION

The potential for ecological risk is quantified during risk characterization. This phase, which represents the last stage of the BERA, is build around three sequential steps: 1) risk estimation; 2) uncertainty analysis; and 3) risk description.

The exposure analysis and effects analysis are integrated during risk estimation to determine the likelihood of adverse effects to the assessment endpoints, given the assumptions inherent in the analysis phase. The uncertainty analysis provides a context for the influences of those assumptions on the risk characterization process. Finally, the risk findings are summarized, interpreted, and discussed in the risk description section using various lines of evidence which address the risk estimates as well as the uncertainties associated with them.

The following three general approaches were used to support risk estimation in this BERA:

- The Hazard Quotient HQ method
- Statistical testing
- Published community health criteria

Exhibit 7.1 summarizes the risk estimation approach for each measurement endpoint.

Exhibit 7.1: Summary of risk estimation approach by receptor group, exposure unit, and measurement endpoint for the aquatic portion of the Ely Copper Mine BERA

Receptor Group	Exposure Units	Exposure	Effect	Risk Estimation Approach
Benthic invertebrates	Ponds; MSEB; SHB; the EBOR	COPECs in bulk sediment	sediment benchmarks	HQ method
	MSEB; SHB; the EBOR	dissolved COPECs in sediment pore water	surface water benchmarks	HQ method
		ΣSEM-AVS	SEM > AVS	Qualitative evaluation of the data
		H. azteca and *C. tentans* exposed for 96 hrs to sediment pore water in the laboratory	survival; growth	statistical testing
		H. azteca and *C. tentans* exposed for 28 d and 10 d, respectively, to bulk sediment in the laboratory	survival; growth	statistical testing
		benthic invertebrate community assessment in the field	community structure & function	statistical testing; VT benthic community health criteria

Exhibit 7.1: Summary of risk estimation approach by receptor group, exposure unit, and measurement endpoint for the aquatic portion of the Ely Copper Mine BERA				
Receptor Group	**Exposure Units**	**Exposure**	**Effect**	**Risk Estimation Approach**
Water column invertebrates	Ponds	dissolved COPECs in surface water	surface water benchmarks	HQ method
		C. dubia (water flea) exposed for 7 days to surface water in the laboratory	survival; reproduction	The data could not be used because the test did not meet TAC
Fish	MSEB; SHB; the EBOR	dissolved COPECs in surface water	surface water benchmarks	HQ method
		P. promelas (fathead minnow) exposed for 7 days to surface water in the laboratory	survival; growth	statistical testing
	SHB and the EBOR	COPECs in whole fish collected from the field	CBRs	HQ method
		fish community assessment in the field	community structure & function	statistical testing; VT fish community health criteria
Amphibians	Ponds	dissolved COPECs in surface water	surface water benchmarks	HQ method
		P. promelas (surrogate for amphibian embryo-larvae) exposed for 7 days to surface water in the laboratory	survival and growth	statistical testing
		wood frog egg and tadpoles exposed to pond water in the field	hatching success and initial survival	qualitative evaluation of the data only
Insectivorous birds	SHB; EBOR	food chain modeling to calculate an EDD	bird TRVs	HQ method
Insectivorous mammals	SHB; EBOR	food chain modeling to calculate an EDD	mammal TRVs	HQ method
Piscivorous birds	SHB; EBOR	food chain modeling to calculate an EDD	bird TRVs	HQ method
Piscivorous mammals	SHB; EBOR	food chain modeling to calculate an EDD	mammal TRVs	HQ method

BERA = baseline ecological risk assessment
CBR = critical body residue
COPEC = contaminant of potential ecological concern
EBOR = east branch of the Ompompanoosuc River
EDD = estimated daily dose
MSEB = main stem of Ely Brook
HQ = hazard quotient
SHB = Schoolhouse Brook
TRV = toxicity reference value
VT = Vermont

7.1.1 Hazard quotient

7.1.1.1 Calculating HQs

The HQ method compares measured or estimated exposures (i.e., sediment EPCs, pore water EPCs, surface water EPCs, whole fish EPCs, and wildlife EDDs) to corresponding toxicity values (i.e., sediment or surface water benchmarks, fish CBRs, or wildlife TRVs). A COPEC-specific HQ is calculated using the following general equation:

$$HQ = \text{exposure concentration} \div \text{toxicity value} \qquad \text{(eq. 8.1)}$$

7.1.1.2 Interpreting the potential for ecological risk using the HQ

The HQ approach used in this risk characterization determines potential ecological risk for two types of exposures (i.e., CTE and RME) using two sets of toxicity values (i.e., no effect and effect benchmarks, or the acute and chronic benchmarks for surface water and sediment pore water). Hence, this approach generated six possible risk outcomes, together with a confidence level, for each COPEC (see **Exhibit 7.2**).

Exhibit 7.2: Interpretative risk matrix for HQs

Risk Scenario	RME Case	CTE case	Risk Conclusion	Confidence Level
1	N ≤ 1 and E ≤1	N ≤ 1 and E ≤ 1	Adverse effects are unlikely	high
2	N > 1 and E ≤ 1	N ≤ 1 and E ≤ 1	Adverse effects are unlikely	moderate
3	N > 1 and E > 1	N ≤ 1 and E ≤ 1	Adverse effects are unlikely	low
4	N > 1 and E ≤ 1	N > 1 and E ≤ 1	Adverse effects are possible	low
5	N > 1 and E > 1	N > 1 and E ≤ 1	Adverse effects are possible	moderate
6	N > 1 and E > 1	N > 1 and E > 1	Adverse effects are possible	high

N = an HQ based on dividing an exposure by its appropriate **n**o effect benchmark (or its "acute" benchmarks for surface water exposures)
E = an HQ based on dividing an exposure by its appropriate **e**ffect benchmark (or its "chronic" benchmarks for surface water exposures)

Risk scenario 1 at one end of the spectrum predicts with high confidence that adverse effects are unlikely because neither the RME nor the CTE exceed their no effect benchmarks. Risk scenario 6 at the other end of the spectrum predicts with high confidence that adverse effects are possible because both the RME and the CTE exceed their effect benchmarks. The interpretative risk matrix is used to provide a richer context to help understand the potential for ecological risk based on HQs. This matrix could not be used with risk estimates based on statistical testing or field community surveys.

7.1.1.3 Calculating incremental risk for HQs

The potential for risk derived from past mining-related activities must be differentiated from risks associated with local reference conditions. This goal was achieved by calculating the Incremental Risk (IR) for each COPEC evaluated using the HQ method, as follows:

$$IR = \text{site HQ} - \text{reference HQ} \qquad \text{(eq. 8.2)}$$

Reference risk exceeded site risk if the IR for a particular COPEC fell below 1.0. Under those circumstances, any site risk for that COPEC was considered unrelated to Site activities. If the IR was above 1.0, then the site risk exceeded reference risk and the residual suggested the potential for Site-related risk. IRs could not be calculated for measurement endpoints other than HQs (i.e., all of the toxicity tests and the two field community surveys).

An HQ risk analysis based on **Exhibit 7.2** would have been unwieldy if it discussed both the no effect and the effect RME case and CTE case for each combination of COPEC, receptor, and EU. Instead, the discussion focused on the effect RME and CTE case (or the chronic RME and CTE case for surface water and pore water) in order to identify the risks with the greatest impacts on future management decision making.

For the same reason, the final risk conclusion for each HQ-based measurement endpoint (see **Attachments 8.1 to 8.7** in Section 8) focused further on the CTE effect (or chronic) IR case, which is represented by risk scenario 6 in **Exhibit 7.2**. Note, however, that all of the risk tables in the BERA provide the HQs for both the no effect (or acute) and the effect (or chronic) RME case and CTE case for completeness and easy referral.

Finally, the discussions below implicitly assumed that the potential for ecological risk increased with higher HQs or IRs. No attempt was made to quantify the term "higher" because HQs and IRs do not measure relative risk, nor are they linearly scaled metrics of risk. Instead, the text simply reflected the general view that higher HQs or IRs were less desirable than lower values, if only because the former may have an (unmeasurable) increased likelihood of resulting in an ecological risk.

7.1.2 Statistical testing

Statistics were used to analyze the results of all the toxicity tests (sediment, pore water, surface water both in the laboratory and in the field). A potential for ecological risk was assumed to be present if the responses observed in the Site samples were statistically different from those measured at the reference location(s). IRs could not be calculated for the measurement endpoints based on statistical testing.

7.1.3 Community health criteria

The benthic invertebrate and fish community data collected from the waterways at and downstream from the Site were compared to upstream reference locations and to community health criteria developed by the State of Vermont for these types of habitats. Ecological risk was assumed to be present if the index of biotic integrity measured at a Site location fell below the published thresholds indicative of non-impaired communities. IRs could not be calculated for the measurement endpoints based on community surveys.

7.2 ASSESSMENT ENDPOINT 1: BENTHIC INVERTEBRATES

A stable and healthy benthic invertebrate community: *Are the COPEC levels in sediment sufficiently high to cause biologically-significant changes or impair the function of the benthic invertebrate community in the on-site ponds and the three streams affected by the Site?*

The potential for ecological risk to the benthic invertebrate community in the ponds, main stem of Ely Brook, Schoolhouse Brook, and the EBOR were assessed using five measurement endpoints.

7.2.1 <u>Measurement endpoint 1.A:</u>

Compare the COPEC levels in bulk sediment samples to no effect and effect sediment benchmarks

- **On-Site ponds**

  Pond 2:

  Site RME and CTE effect HQs were exceeded only by Cr (**Attachment 7.1**).

  No reference RME and CTE effect HQs exceeded 1.0 (**Attachment 7.2**).

  None of the RME and CTE effect IRs exceeded 1.0 either (**Attachment 7.3**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was unlikely in pond 2.

  Pond 3:

  Site RME and CTE effect HQs were exceeded only by Mn (**Attachment 7.4**).

  No reference RME and CTE effect HQs exceeded 1.0 (**Attachment 7.2**).

  The RME and CTE effect IRs for Mn equaled 2.4 and 2.5, respectively (**Attachment 7.5**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was possible in pond 3. However, the exceedances of Mn in bulk sediment were small and unlikely to cause severe impairment.

  Pond 4:

  Site RME and CTE effect HQs were exceeded by Cu, Mn, and Ni (**Attachment 7.6)**.

  No reference RME and CTE effect HQs exceeded 1.0 (**Attachment 7.2**).

  The RME and CTE effect IRs exceeded 1.0 for Cu (RME IR = 2.1 and CTE IR = 2.2) and Mn (RME IR = 1.7 and CTE IR = 1.2) (**Attachment 7.7**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was possible in pond 4. However, the exceedances by both Cu and Mn in bulk sediment were small and unlikely to cause severe impairment by themselves.

  Pond 5:

  Site RME and CTE effect HQs were exceeded by Cu, Mn, Ni, and Zn (**Attachment 7.8)**.

  No reference RME and CTE effect HQs exceeded 1.0 (**Attachment 7.2**).

  The RME and CTE effect IRs exceeded 1.0 only for Cu (RME IR = 23 and CTE IR = 23) (**Attachment 7.9**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was possible in pond 5. The presence of high concentrations of Cu in bulk sediment was likely to cause severe impairment.

- **Main stem of Ely Brook**

  Site RME and CTE effect HQs were exceeded by Cu, Fe, Mn, and Ag (**Attachment 7.10**).

  Reference RME and CTE effect HQs were exceeded by Cu and Mn (**Attachment 7.11)**.

  The RME and CTE effect IRs exceeded 1.0 for Cu (RME IR = 21 and CTE IR = 19) and Fe (RME IR = 3.0 and CTE IR = 2.7) (**Attachment 7.12**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was possible in the main stem of Ely Brook. The presence of high concentrations of Cu in bulk sediment was likely to cause severe impairment.

- **Schoolhouse Brook**

  Site RME and CTE effect HQs were exceeded only by Cu (**Attachment 7.13**).

  None of the reference RME and CTE effect HQs exceeded 1.0 (**Attachment 7.14)**.

  The RME and CTE effect IRs exceeded 1.0 only for Cu (RME IR = 3.2 and CTE IR = 1.9) (**Attachment 7.15**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community was possible in the main stem of Ely Brook. However, the exceedances for Cu in bulk sediment were small and unlikely to cause severe impairment by themselves.

- **The EBOR**

  None of the Site or reference RME and CTE effect HQs exceeded 1.0 (**Attachments 7.16 and 7.17**). Hence, none of the effect RME and CTE IRs exceeded 1.0 either (**Attachment 7.18**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community exposed to bulk sediment was unlikely in the EBOR.

Risk conclusion for measurement endpoint 1.A

Measurement endpoint 1.A identified Cu as a likely stressor to the benthic invertebrate communities exposed to sediment in pond 5 and the main stem of Ely Brook. One or two small exceedances of RME and CTE effect IRs were also present in ponds 3 and 4, and in Schoolhouse Brook, but were unlikely to cause severe impairment by themselves. No risk to the benthic invertebrate communities was identified in pond 2 and the EBOR based on sediment benchmark exceedances. The WOE for this measurement endpoint was “low”.

7.2.2 Measurement endpoint 1.B:

Compare the dissolved COPEC levels in sediment pore water samples to surface water benchmarks

- **On-Site ponds**

  Sediment pore water samples were not collected from any of the ponds on the east branch of Ely Brook for chemical analyses.

- **Main stem of Ely Brook**

  Site RME and CTE chronic HQs were exceeded by Al, Be, Cd, Co, Cu, Mn, Hg, and Zn (**Attachment 7.19**).

  Reference RME and CTE chronic HQs were exceeded by Al, Be, Cd, Mn, and Hg (**Attachment 7.20**).

  The RME and CTE chronic IRs were exceeded by Al (RME IR = 4.2 and CTE IR < 1.0), Cd (RME IR = 4.9 and CTE IR < 1.0), Co (RME IR = 3.9 and CTE IR = 1.3), Cu (RME IR = 14 and CTE IR = 4.7), and Mn (RME IR = 30 and CTE IR = 6.4) (**Attachment 7.21**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community in the main stem of Ely Brook was possible from exposure to sediment pore water. The presence of relatively high concentrations of Cu and Mn was likely to cause impairment.

- **Schoolhouse Brook**

  Site RME and CTE chronic HQs were exceeded by Al, Be, Cd, Cu, Mn, Se,Tl, and Zn (**Attachment 7.22**).

  Reference RME and CTE chronic HQs were exceeded by Al, Be, Cd, and Mn (**Attachment 7.23**).

  The RME and CTE chronic IRs were exceeded by Al (RME IR = 1.2 and CTE IR < 1.0), Cd (RME IR = 1.1 and CTE IR < 1.0), Cu (RME IR = 2.7 and CTE IR < 1.0), Se (RME IR = 1.4 and CTE IR < 1.0), Tl (RME IR = 12 and CTE IR = 6.7), and Zn (RME IR = 1.2 and CTE IR < 1.0) (**Attachment 7.24**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community in Schoolhouse Brook was possible from exposure to sediment pore water. The presence of relatively high concentrations of Tl was likely to cause impairment.

- **The EBOR**

  Site RME and CTE chronic HQs were exceeded by Be, Mn, and Hg (**Attachment 7.25**).

  Reference RME and CTE chronic HQs were exceeded by the same three COPECs (**Attachment 7.26**).

  The RME and CTE chronic IRs were not exceeded by any of the COPECs (**Attachment 7.27**).

  It was concluded, with a high level of confidence, that risk to the benthic invertebrate community in the EBOR was unlikely in response to exposure to sediment pore water.

Risk conclusion for measurement endpoint 1.B

Measurement endpoint 1.B identified Cu and Mn in sediment pore water as likely stressors to the benthic invertebrate community in the main stem of Ely Brook. Tl in sediment pore water was identified as a likely stressor to the benthic invertebrate community in Schoolhouse Brook. Several additional small exceedances of RME effect IRs were also observed in both streams, but were unlikely to cause severe impairment by themselves. No risk to the benthic invertebrate community was identified in the EBOR based on benchmark exceedances. The WOE for this measurement endpoint was “low”.

7.2.3 Measurement endpoint 1.C

Estimate the bioavailability of divalent metals in sediment based on SEM/AVS

SEM and AVS measurements were obtained from the main stem of Ely Brook, Schoolhouse Brook, and the EBOR between 2000 and 2006 (note: samples for SEM and AVS analyses were not collected from any of the reference locations). Toxicity to benthic invertebrates from exposure to divalent metals is not expected when AVS exceeds SEM (i.e., SEM/AVS < 1.0, meaning that all of the available SEM in the sediment is bound up by the AVS). Toxicity to benthic invertebrates is possible when SEM exceeds AVS (i.e., SEM/AVS $\geq$ 1.0, meaning that not enough AVS is present to bind all of the available SEM in the sediment) (EPA, 2006). TOC is another binding phase which should be considered when quantifying metals bioavailability in sediment (EPA, 2006). Only one of the SEM and AVS samples collected from the waterways was analyzed for TOC. Hence, TOC was not considered further.

Attachment 7.28 summarizes the SEM and AVS data. Two general observations follow:

- Little or no AVS was present in any of the sediment samples. This pattern was not surprising given the coarse nature of the sediment, and the high energy, high oxygen, and low organic carbon environment found in the waterways. Such physical and chemical conditions do not favor the anoxia needed to generate large amounts of AVS.
- Cu predominated as the major SEM metal in sediment from the main stem of Ely Brook and in Schoolhouse Brook. Zn became a second major SEM metal in sediment from the EBOR due to the lower concentrations of Cu.

- **The ponds**

Sediment samples were not collected from the ponds on the east branch of Ely Brook for SEM and AVS analyses.

- **Main stem of Ely Brook**

Nine sediment samples were collected from the main stem of Ely Brook for SEM and AVS analyses. All nine samples showed SEM/AVS ratios > 1.0, indicating the presence of bioavailable divalent metals (**Attachment 7.28**).

- **Schoolhouse Brook**

Ten sediment samples were collected from Schoolhouse brook for SEM and AVS analyses. All ten samples showed SEM/AVS ratios > 1.0, indicating the presence of bioavailable divalent metals (**Attachment 7.28**).

- **The EBOR**

Five sediment samples were collected from the EBOR for SEM and AVS analyses. All five samples showed SEM/AVS ratios > 1.0, indicating the presence of bioavailable divalent metals (**Attachment 7.28**). In general, however, the SEM/AVS ratios were greatly reduced in the EBOR as compared to the two upstream waterways.

Risk conclusion for measurement endpoint 1.C

Measurement endpoint 1.C indicated that Cu (and to a lesser degree Zn) was bioavailable in most of the sediment samples collected from the main stem of Ely Brook, Schoolhouse Brook, and the EBOR. The SEM/AVS ratios were high in the main stem of Ely Brook and Schoolhouse Brook, but noticeably lower in the EBOR. The potential for impact to the benthic invertebrate community was present in all three waterways due to the bioavailability of divalent metals in the substrate. The WOE for this measurement endpoint was “low”.

7.2.4 Measurement endpoint 1.D

Measure survival in H. azteca and C. tentans exposed for 96 hours in the laboratory to sediment pore water samples.

- **The ponds**

  Sediment pore water samples were not collected from the ponds on the east branch of Ely Brook for toxicity testing.

- **Main stem of Ely Brook**

  The three pore water samples collected in August 2006 from substrate in the main stem of Ely Brook were acutely toxic to the amphipod *H. azteca*, but not to the chironomid fly larvae *C. tentans*. The risk evaluation focused on the amphipod since it was the most sensitive of the two test species. The presence of acute toxicity in all three pore water samples showed that conditions in the substrate of the main stem of Ely Brook were unsuitable for sensitive benthic invertebrates under short-term (96 hr) exposures at the time of pore water sampling.

- **Schoolhouse Brook**

  The three pore water samples collected from Schoolhouse brook below the confluence with Ely Brook in August 2006 were not acutely toxic to either *H. azteca* or *C. tentans*. This evidence showed that conditions in the substrate were suitable for sensitive benthic invertebrates under short-term (96 hr) exposures at the time of pore water sampling.

- **The EBOR**

  The one pore water sample collected from the EBOR below the confluence with Schoolhouse brook in August 2006 was not acutely toxic to either *H. azteca* or *C. tentans*. This evidence showed that conditions in the substrate were suitable for intolerant benthic invertebrates under short-term (96 hr) exposures at the time of pore water sampling.

Risk conclusion for measurement endpoint 1.D

Measurement endpoint 1.D indicated the presence of significant ecological risk to the benthic invertebrate community from exposure to sediment pore water collected from the main stem of Ely Brook, but not from Schoolhouse Brook or the EBOR. The WOE for this measurement endpoint was “medium”.

7.2.5 Measurement endpoint 1.E

Measure survival and growth in the benthic invertebrate species H. azteca and C. tentans exposed in the laboratory for 28 days and 10 days, respectively, to bulk sediment samples

- **The ponds**

  Bulk sediment samples were not collected from the ponds on the east branch of Ely Brook for sediment toxicity testing

- **Ely Brook**

  Both test species showed toxicity when exposed to two of the three sediment samples collected from the main stem of Ely Brook. The non-toxic sample had the highest Cu concentrations in the bulk sediment and the pore water phase. It appears that the high pH and relatively hard renewal water used in the toxicity test may have precipitated out the Cu, thereby making it non bioavailable.

- **Schoolhouse Brook**

  Both test species showed toxicity when exposed to the three sediment samples (plus the duplicate) collected from AMD-impacted reach of Schoolhouse Brook.

- **The EBOR**

  Neither test species showed toxicity when exposed to the sediment sample collected less than 0.5 miles downstream of the confluence of Schoolhouse Brook with the EBOR.

Risk conclusion for measurement endpoint 1.E

Measurement endpoint 1.E indicated the presence of significant ecological risk to the benthic invertebrate community from exposure to bulk sediment collected from the main stem of Ely Brook and the AMD-impacted reach of Schoolhouse Brook, but not from the EBOR. The WOE for this measurement endpoint was “medium-high”.

7.2.6 Measurement endpoint 1.F

Evaluate the structure and function of the benthic invertebrate community in the field

- **The ponds**

The structure and function of the benthic invertebrate community was not quantitatively evaluated in the ponds on the east branch of Ely Brook

- **Ely Brook**

Surveys in the main stem of Ely Brook showed that the benthic invertebrate community was severely impaired in the entire section of the stream affected by AMD. Conditions did not improve appreciably between 1987 and 2006. The upstream reference location in Ely Brook supported a healthy benthic community.

- **Schoolhouse Brook**

Surveys in Schoolhouse Brook showed that the benthic invertebrate community was severely impaired in the entire section between the confluence of Ely Brook and the EBOR. Conditions did not improve appreciably between 1987 and 2006. The upstream reference locations in Schoolhouse Brook supported a healthy benthic community.

- **The EBOR**

Surveys in the EBOR showed that the benthic invertebrate community was not impaired in the section below the confluence with Schoolhouse Brook. Conditions stayed stable between 2005 and 2006. The upstream reference locations in Schoolhouse Brook also supported a healthy benthic community.

Risk conclusion for measurement endpoint 1.F

The evidence indicated that significant ecological risk to the benthic invertebrate community was present in the main stem of Ely Brook and in Schoolhouse Brook, but not in the EBOR. The WOE for this measurement endpoint is “high”. The level of confidence in this conclusion was also high because it was based on sampling the benthic community in the field over time under standard conditions plus analyzing and interpreting the results using recognized protocols.

7.2.7 WOE integration for assessment endpoint 1

Attachment 7.29 summarizes the WOE integration for the six measurement endpoints evaluated under assessment endpoint 1. The preponderance of the evidence strongly indicated that the benthic community in ponds 4 and 5, the main steam of Ely Brook and the entire reach of Schoolhouse Brook between the confluence of Ely Brook down to the EBOR was severely affected by AMD from the Site. The evidence also showed that the benthic community in the EBOR below the confluence with Schoolhouse Brook was healthy.

7.3 ASSESSMENT ENDPOINT 2: WATER COLUMN INVERTEBRATES

A stable and healthy water column invertebrate community: *Are the levels of COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the water column invertebrate community in the ponds at the Site?*

The potential for ecological risk to the water column invertebrate community associated with the four on-Site ponds was assessed using two measurement endpoints.

7.3.1 Measurement endpoint 2.A

Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.

- **The ponds**

  Pond 2:

  Site RME and CTE chronic HQs were exceeded by Be, Cu, Mn, Ag, and Zn (**Attachment 7.30)**.

  Reference RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Cu, Pb, Se, Ag, and Zn (**Attachment 7.31)**.

  The RME and CTE chronic IRs exceeded 1.0 or Cu (RME IR = 4.1 and CTE IR < 1.0) and Mn (RME IR = 12 and CTE IR = 4.4) (**Attachment 7.32**).

  It was concluded, with a high level of confidence that risk to the water column invertebrate community was possible in pond 2. However, the CTE chronic IR exceedance for dissolved Mn was small and would be unlikely to cause severe impairment.

  Pond 3:

  Site RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Mn, and Ag (**Attachment 7.33)**.

  Reference RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Cu, Pb, Se, Ag, and Zn (**Attachment 7.31)**.

The RME and CTE chronic IRs exceeded 1.0 only for Cr (RME IR = 1.3 and CTE IR < 1.0) and Mn (RME IR = 3.6 and CTE IR = 3.6) (**Attachment 7.34**).

It was concluded, with a high level of confidence, that risk to the water column invertebrate community was possible in pond 3. However, the CTE chronic IR exceedance for dissolved Mn was small and would be unlikely to cause severe impairment.

Pond 4:

Site RME and CTE chronic HQs were exceeded by Be, Cu, Mn, Se, Ag, and Zn (**Attachment 7.35)**.

Reference RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Cu, Pb, Se, Ag, and Zn (**Attachment 7.31)**.

The RME and CTE chronic IRs exceeded 1.0 for Cu (RME IR = 6.6 and CTE IR < 1.0) and Mn (RME IR = 1.7 and CTE IR <1.0) (**Attachment 7.36**).

It was concluded, with a moderate level of confidence, that risk to the water column invertebrate community was possible in pond 4. However, neither dissolved Cu nor dissolved Mn exceeded their CTE chronic IRs, suggesting that these two COPECs were unlikely to cause severe impairment.

Pond 5:

Site RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Cu, Pb, Mn, Se, Ag, and Zn (**Attachment 7.37)**.

Reference RME and CTE chronic HQs were exceeded by Be, Cd, Cr, Cu, Pb, Se, Ag, and Zn (**Attachment 7.31)**.

The RME and CTE chronic IRs exceeded 1.0 for Cr (RME IR = 3.2 and CTE IR < 1.0), Cu (RME IR = 74 and CTE IR = 45), Pb (RME IR = 29 and CTE IR < 1.0), Mn (RME IR = 3.5 and CTE IR = 1.5), and Zn (RME IR = 1.5 and CTE IR = 1.9) (**Attachment 7.38**).

It was concluded, with a high level of confidence that risk to the water column invertebrate community was possible in pond 5. The high levels of dissolved Cu were likely to cause severe impairment.

Risk conclusion for measurement endpoint 2.A

Measurement endpoint 2.A identified dissolved Cu as a likely stressor to the water column invertebrate community in pond 5. One or two small exceedances of RME and IR CTE chronic IRs were also present in ponds 2, 3 and 4, but appeared unlikely to cause severe impairment by themselves. The WOE for this measurement endpoint was “low”.

7.3.2 <u>Measurement endpoint 2.B</u>

Measure survival and reproduction in the water flea, C. dubia, exposed for seven days in the laboratory to surface water samples.

- **The ponds**

The *C. dubia* test performed on surface water samples collected from ponds 4 and 5 failed to meet the minimum test acceptability criteria. No toxicity data were available for evaluation in the BERA.

7.3.3 WOE integration for assessment endpoint 2

Attachment 7.39 summarizes the WOE integration for the one measurement endpoint evaluated under assessment endpoint 2. The available evidence strongly indicated that the surface water in pond 5 was severely impaired by dissolved Cu. The surface waters in ponds 2 and 3 also showed the potential for impairment but at a much less severe level. The surface water in pond 4 was unlikely to have severe effects on the water column invertebrate community.

7.4 ASSESSMENT ENDPOINT 3: FISH

A stable and healthy fish community: *Are the levels of COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the fish community at the on-Site ponds and in the three streams affected by the Site?*

Four measurement endpoints were used to assess the potential impacts of COPECs to this receptor group:

7.4.1 Measurement endpoint 3.A

Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.

- **The ponds**

  The potential for ecological risk to fish in the four ponds on the east branch of Ely Brook was not assessed because no fish were observed in these ponds, including pond 1 (the on-Site reference pond).

- **Main stem of Ely Brook**

  The potential for ecological risk to fish was assessed, even though the main stem of Ely Brook is unable to support fish under current conditions.

  Site RME and CTE chronic HQs were exceeded by Al, Cd, Co, Cu, Fe, Mn, Ag, and Zn (**Attachment 7.40)**.

  Reference RME and CTE chronic HQs were exceeded by Cd, Cu, Mn, and Ag (**Attachment 7.41)**.

  The RME and CTE chronic IRs exceeded 1.0 for Al (RME IR = 213 and CTE IR = 68), Co (RME IR = 14 and CTE IR = 4.0), Cu (RME IR = 611 and CTE IR = 281), Fe (RME IR = 40 and CTE IR = 10), Mn (RME IR = 7.5 and CTE IR = 4.5), Ag (RME IR = 1.4 and CTE IR <1.0), and Zn (RME IR = 4.3 and CTE IR = 3.7) (**Attachment 7.42**).

  It was concluded, with a high level of confidence, that risk to the fish community was possible in the main stem of Ely Brook. The high levels of dissolved Al, Cu, and Fe in particular were likely to cause severe impairment to the local fish community.

- **Schoolhouse Brook**

  Site RME and CTE chronic HQs were exceeded by Al, Cd, and Cu (**Attachment 7.43)**.

Reference RME and CTE chronic HQs were exceeded by Cd (**Attachment 7.44)**.

The RME and CTE chronic IRs exceeded 1.0 only for Cu (RME IR = 12 and CTE IR = 7.8) (**Attachment 7.45**).

It was concluded, with a high level of confidence, that risk to the fish community was possible in Schoolhouse Brook. The high levels of dissolved Cu were likely to cause severe impairment to the local fish community.

- **The EBOR**

Site RME and CTE chronic HQs were exceeded by Ba, Cu, Pb, Ag, and Zn (**Attachment 7.46)**.

Reference RME and CTE chronic HQs were exceeded by Pb and Ag (**Attachment 7.47)**.

The RME and CTE chronic IRs exceeded 1.0 for Cu (RME IR = 3.1 and CTE IR = 1.1), Pb (RME IR = 1.4 and CTE IR < 1.0), Ag (RME IR = 1.1 and CTE IR = 8.0), and Zn (RME IR = 39 and CTE IR= 6.5) (**Attachment 7.48**).

It was concluded, with a high level of confidence, that risk to the fish community was possible in the EBOR. The high levels of dissolved Ag and Zn were likely to cause severe impairment to the local fish community.

Risk conclusion for measurement endpoint 3.A

Measurement endpoint 3.A identified dissolved Cu as the most likely stressor to fish in the main stem of Ely Brook and Schoolhouse Brook. Dissolved Ag and dissolved Zn were risk drivers in the EBOR. All three EUs appeared likely to be impaired based on an evaluation of surface water chemistry. The WOE for this measurement endpoint was “low”.

7.4.2 <u>Measurement endpoint 3.B</u>

Survival and growth in juvenile fathead minnows (P. promelas).

- **The ponds**

The potential for risk to fish was not assessed because these receptors are absent from the ponds (note: fathead minnow neonates were exposed to surface water samples collected from ponds 4 and 5. However, the organisms were used as surrogates for the embryo-larval life stages of amphibians. The results of these exposures are evaluated in Section 7.5).

- **Ely Brook**

Fathead minnow neonates were exposed in the laboratory to surface water collected from one location on the main stem of Ely Brook. None of the fish survived the seven-day exposure, indicating that surface water from the main stem of Ely Brook was highly toxic to juvenile fish.

- **Schoolhouse Brook**

Fathead minnow neonates were exposed in the laboratory to surface water collected from four locations on Schoolhouse Brook. These locations were just downstream of the confluence of Ely Brook with Schoolhouse Brook, adjacent to the lower end of the slag piles, about midway between Ely Brook and the EBOR, and just upstream of the confluence between Schoolhouse Brook and the EBOR. Fish survival after seven days of exposure was significantly reduced at all four locations, indicating that surface water along the entire reach of Schoolhouse Brook between Ely Brook and the EBOR (about 2.2 miles) was toxic to juvenile fish.

- **The EBOR**

  No Surface water samples were collected from the EBOR for toxicity testing using fathead minnows.

Risk conclusion for measurement endpoint 3.B

Measurement endpoint 3.B identified severe ecological risk to fish in the main stem of Ely Brook and in Schoolhouse Brook based on surface water toxicity testing in the laboratory. The surface water flowing through these two affected habitats cannot support a healthy fish community under current conditions. No conclusions can be made for the EBOR since the toxicity of its surface water to fish was not tested. The WOE for this measurement endpoint was “medium”

7.4.3 <u>Measurement endpoint 3.C</u>

Compare COPEC levels measured in whole fish to no effect and effect CBRs

- **The ponds**

  The potential for risk to fish was not evaluated using this measurement endpoint because the ponds do not support fish.

- **Main stem of Ely Brook**

The potential for risk to fish was not evaluated using this measurement endpoint because the main stem of Ely Brook does not support fish.

- **Schoolhouse Brook**

  - Brook trout

  Site RME and CTE effect HQs were exceeded only by Cu (**Attachment 7.49)**.

  None of the reference RME and CTE effect HQs were exceeded in the non-impacted section (**Attachment 7.50)**.

  The RME and CTE effect IRs were exceeded only by Cu (RME IR = 2.6 and CTE IR = 2.5) (**Attachment 7.51)**.

  - Blacknose dace

  Site RME and CTE effect HQs were exceeded only by Cu (**Attachment 7.52)**.

  The reference RME and CTE effect HQs were exceeded only by Al in the non-impacted section (**Attachment 7.53)**.

  The RME and CTE effect IRs were exceeded only by Cu (RME IR = 2.0 and CTE IR = 1.3) (**Attachment 7.54)**.

- **The EBOR**

  - Brook trout

  None of the site RME and CTE effect HQs were exceeded in the EBOR (**Attachment 7.55)** and all of the RME and CTE effect IRs fell below 1.0 (**Attachment 7.56)** (note: no brook trout were collected from the upstream reference location on the EBOR).

  - Blacknose dace

  Site RME and CTE effect HQs were exceeded only by Al and Cu (**Attachment 7.57)**.

  None of the reference RME and CTE effect HQs or the RME and CTE effect IRs exceeded 1.0 (**Attachments 7.58 and 7.59)**.

Risk conclusion for measurement endpoint 3.C

Measurement endpoint 3.C identified the potential for ecological risk to fish in Schoolhouse Brook, but not in the EBOR, based on comparing tissue residue levels to conservative fish CBRs. The Cu levels were relatively low in the fish collected from Schoolhouse Brook. It is possible, however, that fish with substantially higher tissue burdens of Cu died out and were eliminated from the population. The WOE for this endpoint was "medium".

7.4.4 Measurement endpoint 3.D

Evaluate the structure and function of the fish community

- **The ponds**

  The potential for risk to fish was not evaluated using this measurement endpoint because none of the ponds (including the reference pond) supported fish.

- **Main stem of Ely Brook**

  The potential for risk to fish could not be evaluated using this measurement endpoint because fish were absent from the main stem of Ely Brook. The lack of fish was seen as indicative of exposure to AMD.

- **Schoolhouse Brook**

  Field surveys in Schoolhouse Brook showed that the fish community was severely impaired in the entire section of Schoolhouse brook between the confluence of Ely Brook and the EBOR. The reference sites located immediately upstream of the confluence of Ely Brook supported a healthy fish community, indicating that the observed impairment further downstream was a direct result of exposure to AMD.

- **The EBOR**

  Field surveys in the EBOR showed that the fish community was not likely affected by AMD. The sampling station on the EBOR immediately below the confluence with Schoolhouse Brook supported a healthy fish community, even though the community was rated as "poor" at two of the three locations further downstream. The fish community at one of those two locations went from "poor" to "good" between 2006 and 2007. This unexpected improvement seems to have resulted from an unknown sampling bias. Overall, the data did not suggest that the fish community in the

EBOR was systematically impaired by AMD, even though the evidence was not as conclusive as it could have been.

Risk conclusion for measurement endpoint 3.D

Measurement endpoint 3.D indicated severe ecological risk to fish in the main stem of Ely Brook (devoid of fish) and Schoolhouse brook (severe impairment) based on fish community surveys. The preponderance of the evidence collected from the EBOR indicated that the fish community was unlikely to be affected by AMD. The WOE for this measurement endpoint was “high”.

7.4.5 WOE integration for assessment endpoint 3

Attachment 7.60 summarizes the WOE integration for the four measurement endpoints evaluated under assessment endpoint 3. The preponderance of the evidence strongly indicated that the fish community in two of the three streams was severely affected by AMD. The main stem of Ely Brook was impaired as indicated by a lack of fish and CTE chronic IRs for Cu well above 100. The entire reach of Schoolhouse Brook between the confluence of Ely Brook down to the EBOR was also impaired as indicated by high CTE chronic IRs for several surface water COPECs and a severely depleted fish community. The fish community in the EBOR appears to be unaffected by AMD.

7.5 ASSESSMENT ENDPOINT 4: AMPHIBIANS

Stable and healthy amphibian populations: *Are the levels of COPECs in surface water sufficiently high to cause biologically-significant changes or impair the function of the amphibian populations in the on-site ponds?*

The potential for ecological risk to the amphibian populations associated with the on-Site ponds was assessed using three measurement endpoints.

7.5.1 Measurement endpoint 4.A

Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks

Note: the evaluation of risk to amphibians under Measurement Endpoint 4.A is identical to the risk evaluation performed for the water column invertebrate community in the ponds under measurement endpoint 2.A (see Section 7.3.1).

Pond 2:

It was concluded, with a high level of confidence that risk to the juvenile stages of amphibians was possible in pond 2. However, the exceedance for dissolved Mn (CTE chronic IR = 4.3) was relatively small and would be unlikely to cause severe impairment to the local amphibian populations.

Pond 3:

It was concluded, with a high level of confidence that risk to the juvenile stages of amphibians was possible in pond 3. However, the exceedance for dissolved Mn (CTE chronic IR = 3.6) was relatively small and would be unlikely to cause severe impairment to the local amphibian populations.

Pond 4:

It was concluded, with a moderate level of confidence that risk to the juvenile stages of amphibians was possible in pond 4. However, neither dissolved Cu nor dissolved Mn had a CTE chronic IR above 1.0, suggesting that those two COPECs were unlikely to cause severe impairment to the local amphibian populations.

Pond 5:

It was concluded, with a high level of confidence that risk to the juvenile stages of amphibians was possible in pond 5. The high levels of dissolved Cu (CTE chronic IR = 45) were likely to cause severe impairment to the local amphibian populations.

Risk conclusion for measurement endpoint 4.A

Measurement endpoint 4.A identified dissolved Cu as a likely stressor to the early life stages of amphibians in pond 5. One or two small exceedances of RME and CTE chronic IRs were also present in ponds 2, 3 and 4, but appeared unlikely to cause severe impairment by themselves. The WOE for this measurement endpoint was "low".

7.5.2 Measurement endpoint 4.B

Survival and growth in juvenile fathead minnows (P. promelas).

- **The ponds**

Fathead minnow neonates (used as surrogates for amphibian embryo-larval stages) were exposed in the laboratory to surface water samples collected from one location in pond 4 and one location in pond 5. Only 20% of the neonates survived in the sample from pond 4, and none survived in the sample from pond 5 after seven days of exposure. These data indicated that the surface water from the two ponds was highly toxic to the embryo-larval stages of amphibians.

Risk conclusion for measurement endpoint 4.B

Severe ecological risk to the early life stages of amphibians was identified in ponds 4 and 5 based on the presence of toxicity in a surrogate species exposed to surface water samples in the laboratory. The WOE for this endpoint is "medium"

7.5.3 Measurement endpoint 4.C

Evaluate hatching and survival of wood frog eggs and tadpoles exposed to the ponds in the field

- **The ponds**

In-situ field test using fertilized wood frog eggs and week-old wood frog tadpoles enclosed in floating cages indicated that the surface water flowing through pond 4 was chronically toxic to week-old tadpoles, whereas the surface water flowing through pond 5 was acutely toxic to newly hatched tadpoles. These data indicated that the surface water from the two ponds was highly toxic to the embryo-larval stages of amphibians and was unsuitable for amphibian breeding.

Risk conclusion for measurement endpoint 4.C

Severe ecological risk to the early life stages of amphibians was identified in ponds 4 and 5 based on exposures of fertilized eggs and tadpoles in the field. The WOE for this endpoint is "medium-high".

7.5.4 WOE integration for assessment endpoint 4

Attachment 7.61 summarizes the WOE integration for the three measurement endpoints evaluated under assessment endpoint 4. The preponderance of the evidence strongly indicated that the surface water flowing through ponds 4 and 5 was severely affected by AMD released from the Site. These two ponds were unable to provide suitable amphibian breeding habitat under existing conditions.

7.6 ASSESSMENT ENDPOINT 5: INSECTIVOSOUS BIRDS

Stable and healthy insectivorous bird populations: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

7.6.1 Measurement endpoint 5.A

Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate the mean and maximum daily doses to tree swallows from ingesting surface water and winged aquatic insects, and compare these values to TRVs.

- **The ponds on the east branch of Ely Brook**

  Risk to insectivorous birds was not evaluated for the four ponds because their surface areas were too small to be considered reasonable EUs for this receptor group.

- **The main stem of Ely Brook**

  Risk to insectivorous birds was not evaluated because aquatic insects were absent from the main stem of Ely Brook. Also, other lines of evidence showed that this habitat was severely degraded.

- **Schoolhouse Brook**

  Site RME and CTE effect HQs were exceeded by Co, Cu, Se, and V (**Attachment 7.62)**.

  Reference RME and CTE effect HQs were not exceeded by any of the COPECs (**Attachment 7.63)**.

  The RME and CTE effect IRs exceeded 1.0 for Co (RME IR = 3.6 and CTE IR = 1.1), Cu (RME IR = 11 and CTE IR = 6.4), and Se (RME IR = 3.9 and CTE IR < 2.5) (**Attachment 7.64**).

  It was concluded, with a high level of confidence, that risk was possible to insectivorous birds feeding at Schoolhouse Brook. Cu was identified as the main risk driver for this receptor group, although the exceedances were relatively small.

- **The EBOR**

  Site RME and CTE effect HQs were exceeded by Co, Cu, Se, and V (**Attachment 7.65)**.

  Reference RME and CTE effect HQs were exceeded by Se and V (**Attachment 7.66)**.

  The RME and CTE effect IRs exceeded 1.0 for Co (RME IR = 5.0 and CTE IR < 1.0) and Cu (RME IR = 2.6 and CTE IR = 1.6) (**Attachment 7.67**).

It was concluded, with a high level of confidence, that risk was possible to insectivorous birds feeding at the EBOR. However, Cu had a CTE effect IR of 1.6, suggesting that this COPEC was unlikely to cause severe long-term impairment to this receptor group.

Risk conclusion for measurement endpoint 5.A

Measurement endpoint 5.A identified Cu as a potential stressor to insectivorous birds feeding at Schoolhouse Brook, but not at the EBOR. The WOE for this measurement endpoint was "medium-low".

7.6.2 WOE integration for assessment endpoint 5

Attachment 7.68 summarizes the WOE integration for the single measurement endpoint evaluated under assessment endpoint 5.A. The preponderance of the evidence strongly indicated that insectivorous birds feeding at Schoolhouse Brook have a potential for ecological risk, mainly from exposure to Cu. However, the risk is not expected to be severe due to the relatively low CTE effect IR exceedance of Cu. The potential for ecological risk to insectivorous birds feeding at the EBOR is present but is considered minimal.

7.7 ASSESSMENT ENDPOINT 6: INSECTIVOROUS MAMMALS

Stable and healthy insectivorous mammal populations: *Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of insectivorous mammal populations foraging along Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

7.7.1 Measurement endpoint 6.A

Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate the mean and maximum daily doses to eastern small-footed bats from ingesting surface water and winged aquatic insects, and compare these values to TRVs

- **The ponds on the east branch of Ely Brook**

  Risk to insectivorous mammals was not evaluated for the ponds because the total surface area of the four ponds was too small to be considered a reasonable EU for this receptor group.

- **The main stem of Ely Brook**

  Risk to insectivorous birds was not evaluated because aquatic insects were absent from the main stem of Ely Brook. Also, other lines of evidence showed that this habitat was severely degraded.

- **Schoolhouse Brook**

  Site RME and CTE effect HQs were exceeded by Co, Cu, Mn, Se, and V (**Attachment 7.69)**.

  Reference RME and CTE effect HQs were exceeded by Cu, Tl, and V (**Attachment 7.70)**.

  The RME and CTE effect IRs exceeded 1.0 for Co (RME IR = 1.8 and CTE IR < 1.0), Cu (RME IR = 40 and CTE IR = 24), and Se (RME IR = 1.4 and CTE IR < 1.0) (**Attachment 7.71**).

  It was concluded, with a high level of confidence, that risk was possible to insectivorous mammals feeding at Schoolhouse Brook. Cu was identified as the main risk driver for this receptor group.

- **The EBOR**

  Site RME and CTE effect HQs were exceeded by Co, Cu, Tl, and V (**Attachment 7.72)**.

  Reference RME and CTE effect HQs were exceeded by Se, Tl, and V (**Attachment 7.73)**.

  The RME and CTE effect IRs exceeded 1.0 for Co (RME IR = 2.5 and CTE IR < 1.0), Cu (RME IR = 10 and CTE IR = 5.9), and V (RME IR = 2.2 and CTE IR < 1.0) (**Attachment 7.74**).

  It was concluded, with a high level of confidence, that risk was possible to insectivorous mammals feeding at the EBOR. Cu was identified as the main risk driver for this receptor group.

Risk conclusion for measurement endpoint 6.A

Measurement endpoint 6.A identified Cu as a potential stressor to insectivorous mammals feeding at Schoolhouse Brook and the EBOR. The potential for ecological risk was substantially higher at Schoolhouse Brook than at the EBOR. The WOE for this measurement endpoint was "medium-low".

7.7.2 WOE integration for assessment endpoint 6

Attachment 7.75 summarizes the WOE integration for the single measurement endpoint evaluated under assessment endpoint 6. The preponderance of the evidence strongly indicated that insectivorous mammals feeding at Schoolhouse Brook and the EBOR have a potential for ecological risk from exposure to Cu. The risk is expected to be substantially higher at Schoolhouse Brook.

7.8 ASSESSMENT ENDPOINT 7: PISCIVOROUS BIRDS

Stable and healthy piscivorous bird populations: *Are the COPEC levels in surface water and biota sufficiently high to impair piscivorous bird populations foraging in Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

7.8.1 Measurement endpoint 7.A

Use food chain modeling to calculate the mean and maximum daily doses to belted kingfishers from ingesting surface water and fish, and compare these values to TRVs

- **The ponds on the east branch of Ely Brook**

  Risk to piscivorous birds was not evaluated for the ponds because the total surface area of the four ponds was too small to be considered a reasonable EU for this receptor group.

- **The main stem of Ely Brook**

  Risk to piscivorous birds was not evaluated for the main stem of Ely Brook because fish cannot live in this section of the brook under current conditions. Hence, fish-eating birds were not expected to forage in that EU. Also, other lines of evidence showed that this habitat was severely degraded.

- **Schoolhouse Brook**

  No COPECs exceeded the site RME and CTE effect HQs (**Attachment 7.76**) or the reference RME and CTE effect HQs (**Attachment 7.77**). Hence, the RME and CTE effect IRs were also below 1.0 for all COPECs (**Attachment 7.78)**.

It was concluded, with a high level of confidence, that risk was not present to the belted kingfisher feeding on fish captured from this aquatic habitat.

- **The EBOR**

  No COPECs exceeded the site RME and CTE effect HQs (**Attachment 7.79**). Reference RME and CTE effect HQs were exceeded only by Se (**Attachment 7.80**). The RME and CTE effect IRs were` below 1.0 for all COPECs (**Attachment 7.81)**.

  It was concluded, with a high level of confidence, that risk was not present to the piscivorous birds feeding at the EBOR.

Risk conclusion for measurement endpoint 7.A

Measurement endpoint 7.A did not identify ecological risk to piscivorous birds feeding at Schoolhouse Brook and the EBOR.

7.8.2 <u>WOE integration for assessment endpoint 7</u>

Attachment 7.82 summarizes the WOE integration for the single measurement endpoint evaluated under assessment endpoint 7. The preponderance of the evidence strongly indicated that piscivorous birds feeding at Schoolhouse Brook and the EBOR will not experience ecological risk from exposure to Site COPECs.

7.9 <u>ASSESSMENT ENDPOINT 8 : PISCIVOROUS MAMMALS</u>

Stable and healthy piscivorous mammal populations: *Are the COPEC levels in surface water and biota sufficiently high to impair piscivorous mammals populations foraging in Schoolhouse Brook and the EBOR?*

One measurement endpoint was used to assess the potential impacts of COPECs ingested by this receptor group:

7.9.1 <u>Measurement endpoint 8.A</u>

Use food chain modeling to calculate the mean and maximum daily doses to mink from ingesting surface water and fish, and compare these values to TRVs

- **The ponds on the east branch of Ely Brook**

  Risk to piscivorous mammals was not evaluated for the ponds because the total surface area of the four ponds was too small to be considered a reasonable EU for this receptor group.

- **The main stem of Ely Brook**

  Risk to piscivorous mammals was not evaluated for the main stem of Ely Brook because current conditions are such that fish cannot live in the brook. Hence, fish-eating birds were not expected to forage in that EU. Also, other lines of evidence showed that this habitat was severely degraded.

- **Schoolhouse Brook**

  No COPECs exceeded the site RME and CTE effect HQs (**Attachment 7.83**) or the reference RME and CTE effect HQs (**Attachment 7.84**). Hence, the RME and CTE effect IRs were also below 1.0 for all COPECs (**Attachment 7.85)**. It was concluded, with a high level of confidence, that risk was not present to the mink feeding on fish captured from Schoolhouse Brook.

- **The EBOR**

  No COPECs exceeded the site RME and CTE effect HQs (**Attachment 7.86**) or the reference RME and CTE effect HQs (**Attachment 7.87**). Hence, the RME and CTE effect IRs were also below 1.0 for all COPECs (**Attachment 7.88)**. It was concluded, with a high level of confidence, that risk was not present to the mink feeding on fish captured from the EBOR.

Risk conclusion for measurement endpoint 8.A

Measurement endpoint 8.A did not identify ecological risk to piscivorous mammals feeding at Schoolhouse Brook and the EBOR.

7.9.2 WOE integration for assessment endpoint 8

Attachment 7.89 summarizes the WOE integration for the single measurement endpoint evaluated under assessment endpoint 8. The preponderance of the evidence strongly indicated that piscivorous mammals feeding at Schoolhouse Brook and the EBOR will not experience ecological risk from exposure to Site COPECs.

7.10 UNCERTAINTY ANALYSIS

7.10.1 Introduction

Uncertainty is an integral part of risk characterization. Many assumptions and decisions were made to generate and manipulate the data used in the risk estimation. A key component of the process is to identify the main sources of uncertainty for each measurement endpoint and see how those uncertainties could affect the outcome of the risk calculations. This information gives a better understanding of how the risk conclusions should be interpreted during the risk management decision-making process. **Attachment 7.90** describes the major uncertainties for the risk estimations of the aquatic portion of the Ely Copper Mine BERA. The text below summarizes this information.

Note that one important uncertainty applies across all of the assessment endpoints evaluated in this BERA. The exposures derived from analytical data (i.e., sediment, pore water, surface water, fish tissues, and EDDs) included all available data points. An outlier test was performed as part of the ProUCL evaluation, but no data points were eliminated as a result. Hence, any of the risks derived from exposures which included one or more statistical outliers has the potential to be somewhat overestimated.

7.10.2 Major uncertainties associated with assessing risk to benthic invertebrates

7.10.2.1 Measurement endpoint 1.A:

Compare sediment COPECs to benchmarks

Overall, it is anticipated that the potential for ecological risk was moderately overestimated for this measurement endpoint. A major reason is that the screening benchmarks were generic and conservative values which did not consider site-specific factors affecting bioavailability. The overestimation of risk should be mitigated because the substrate in the affected waterways had little or no AVS or TOC to bind the COPECs. However, other unquantified phases (e.g., iron oxides) could also have served as binding agents. The second reason was that strong acids were used to release COPECs from the sediment matrix before chemical analyses. These digestions generated conservative data because they did not mimic the bioavailability experienced by aquatic receptors in the field.

7.10.2.2 Measurement endpoint 1.B:

Compare pore water COPECs to benchmarks

Overall, it is anticipated that the potential for ecological risk was moderately underestimated for this measurement endpoint. The main reason was that pore water was collected only during summer base flow when the COPEC load moving through the waterways would have been at a minimum and surface water hardness would be at a maximum. The pore water chemistry would likely have been worse if sampling had occurred when surface water flow was higher (e.g., during spring snowmelt or fall runoff). The potential for severe underestimation of pore water toxicity is somewhat mitigated because the screening benchmarks were generic and conservative values protective of a broad range of aquatic receptors.

7.10.2.3 Measurement endpoint 1.C:

Measure AVS-SEM to estimate the bioavailability of metals in sediment

Overall, it is anticipated that the potential for ecological risk was up to moderately overestimated. The main reason was that sediment is not necessarily toxic when SEM exceeds AVS because other unquantified binding phases (e.g., iron oxides) can decrease the bioavailability of metals in sediment. The lack of TOC data only had a minor effect on the conclusion. The reason was that the sediment in the affected waterways were relatively coarse and therefore unlikely to contain or retain large amounts of TOC.

7.10.2.4 Measurement endpoints 1.D:

Toxicity testing of H. azteca and C. tentans exposed to pore water in the laboratory

Overall, it is anticipated that the potential for ecological risk was moderately to severely underestimated for this measurement endpoint. The main reason for this conclusion was that pore water was collected only during summer base flow when the COPEC load moving through the waterways was at a minimum and surface water hardness would be at a maximum. The pore water chemistry would likely have been worse if sampling had occurred when surface water flow was higher (e.g., during spring snowmelt or after periods of significant rainfall). Also, the 96-hours exposure period only measured short-term toxicity. A lack of mortality after 96 hours did not mean that chronic effects would not have emerged under longer exposures.

7.10.2.5 Measurement endpoint 1.E:

Toxicity testing of H. azteca and C. tentans exposed to sediment in the laboratory

Overall, it is anticipated that the potential for ecological risk was moderately overestimated for this measurement endpoint. The main reason was that the sediment samples were collected from the few available depositional areas in the waterways, which represented a “worse case” exposure scenario. This bias may have been further enhanced because the conditions in the test beakers were more static (= greater chance for COPECs to dissociate from sediment into the interstitial water) than those found in the affected waterways. One the other hand, changes in sediment chemistry in some of the beakers over time could have decreased bioavailability due to metal precipitation, as was the case for one of the bulk sediment samples collected from the main stem of Ely Brook.

7.10.2.6 Measurement endpoint 1.F:

Benthic invertebrate community survey

Overall, it is anticipated that the potential for ecological risk for this measurement endpoint was as reported in the risk characterization. The observed structure of the benthic community represented a long-term, chronic response to local chemical conditions in substrate, pore water, and surface water integrated over time. Also, a comprehensive field survey of the substrate in all of the affected waterways was performed in 2006 before selecting the benthic invertebrate sampling locations. This process minimized the intrinsic variability in community structure commonly found as a result of differences in habitat quality. Finally, the published benthic community metrics used in the field data interpretation were obtained by the State of Vermont from streams with physical and hydrologic characteristics similar to those found in the waterways at the Site.

7.10.3 Major uncertainties associated with assessing risk to water column invertebrates in the ponds

7.10.3.1 Measurement endpoint 2.A:

Compare surface water COPECs to benchmarks

Overall, it is anticipated that the potential for ecological risk in the ponds was moderately underestimated for this measurement endpoint. The main reason was that the surface water data used in the evaluation were collected mostly during May and June. As such, the water chemistry did not represent conditions that would occur during spring snowmelt or after significant rain events throughout the year. The potential for severe underestimation of risk during high flow was somewhat mitigated because the surface water screening benchmarks were generic and conservative values protective of a broad range of sensitive aquatic receptors.

7.10.4 Major uncertainties associated with assessing risk to fish

7.10.4.1 Measurement endpoint 3.A:

Compare surface water COPECs to benchmarks

Overall, it is anticipated that the potential for ecological risk was moderately underestimated for this measurement endpoint. The main reason was that the surface water benchmarks did not account for low pH conditions that may occur in some of the water ways at certain times of the year, in addition to the high COPEC levels. On the other hand, the surface water screening benchmarks were generic and conservative values protective of a broad range of sensitive aquatic receptors. Other potential factors (i.e., a comprehensive surface water chemistry data set for the three waterways, the availability of screening benchmarks for all of the COPECs, and using dissolved metals data) would have had little or no effect on the risk associated with this measurement endpoint.

7.10.4.2 Measurement endpoint 3.B:

Surface water toxicity testing using juveniles of the fathead minnow

Overall, it is anticipated that the potential for ecological risk was moderately underestimated for this measurement endpoint. The main reason for this conclusion was that the surface water samples used in the laboratory toxicity tests were collected during a three-day period in late June of 2006. As such, the water chemistry did not represent more toxic conditions expected during spring snowmelt or after significant rain events throughout the year. Further underestimation of risk is also associated with testing a single fish species for a relatively short duration, and potential changes in the COPEC concentration of the renewal water due to metal precipitation.

7.10.4.3 Measurement endpoint 3.C:

Compare COPECs in fish tissue to CBRs

Overall, it is anticipated that the potential for ecological risk was moderately overestimated for this measurement endpoint. The main reason is that both the species-specific CBRs and final salmonid CBRs represented geometric means of literature-derived tissue residue data. The geometric mean produced conservative CBRs because it minimized the influence of high (= less conservative) tissue levels on the calculations. The potential for CBRs to overestimate risk was somewhat mitigated by the fact that the cumulative risk of multiple COPECs was not considered and fish with excessively high body burdens of COPECs may have died off and would have been excluded from the evaluation.

7.10.4.4 Measurement endpoint 3.D:

Fish community surveys

Overall, it is anticipated that the potential for ecological risk was as reported for this measurement endpoint. The main reasons for this conclusion were that: (1) the overall structure of the local fish community represents a long-term, chronic response to chemical conditions integrated over multiple years, and (2) the published fish community metrics used in the field data interpretation were obtained by the State of Vermont from streams with physical and hydrologic characteristics similar to those found in the waterways at the Site.

7.10.5 <u>Major uncertainties associated with assessing risk to amphibians</u>

7.10.5.1 Measurement endpoint 4.A:

Compare surface water COPECs to benchmarks

Overall, it is anticipated that the potential for ecological risk was slightly underestimated for this measurement endpoint. The main reason was that the surface water benchmarks did not account for low pH conditions that may occur at certain times of the year, in addition to the regular COPEC levels. On the other hand, the surface water screening benchmarks were generic and conservative values protective of a broad range of sensitive aquatic receptors. Also, most of the surface water samples from the ponds were collected during the period of tadpole development (i.e., May and June).

7.10.5.2 Measurement endpoint 4.B:

Surface water toxicity testing using the fathead minnow

Overall, it is anticipated that the potential for ecological risk was moderately underestimated for this measurement endpoint. The main reason was that the surface water samples used in the laboratory toxicity tests were collected during a three-day period in late June of 2006. As such, the water chemistry did not represent the full range of conditions that might occur during the amphibian breeding season. Further underestimation of risk is also associated with using a fish species as a surrogate for amphibians. using a relatively short exposure duration, and potential changes in the COPEC concentration of the renewal water due to metal precipitation.

7.10.5.3 Measurement endpoint 4.C:

In-situ toxicity testing using wood frog eggs and tadpoles

Overall, it is anticipated that the potential for ecological risk could have ranged from as reported to a moderate underestimation for this measurement endpoint. The main reason for this ambiguous conclusion was that it was not known how the sensitivity of the embryo-larval stages of the wood frog used in the *in-situ* toxicity tests compares to that of other local amphibian species (e.g., green frog and eastern newts) known to use the ponds for breeding. Risk is as reported if the wood frog is the most sensitive local amphibian species. However, risk would be moderately underestimated if other local species are more sensitive to the current ambient conditions than the wood frog. The data from the long-term, *in-situ* tadpole exposures were also compromised by the complete mortality observed at both reference locations.

7.10.6 <u>Major uncertainties associated with assessing risk to piscivorous birds and mammals</u>

7.10.6.1 Measurement endpoint 5.A and 6.A:

Food chain modeling using measured fish tissue residue data

Overall, it is anticipated that the potential for ecological risk may be moderately overestimated for this measurement endpoint. The main reasons for this conclusion were that: (1) several of the exposure parameters (mainly area use factors and COPEC bioavailability) used in food chain modeling were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative and non-species-specific values derived from the literature.

7.10.7 <u>Major uncertainties associated with assessing risk to insectivorous birds and mammals</u>

7.10.7.1 Measurement endpoint 7.A and 8.A:

Food chain modeling using estimated insect tissue residue data

Overall, it is anticipated that the potential for ecological risk may be overestimated by a large margin for this measurement endpoint. The main reasons for this conclusion were that: (1) the concentrations of COPECs in insects were obtained using generic, literature-derived BAFs instead of measured tissue residues from insects collected at the Site, (2) several of the exposure parameters (mainly area use factors and COPEC bioavailability) used in food chain modeling were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative and non-species-specific values derived from the literature.

Attachment 7.1
Hazard Quotients for Sediment COPECs in Pond 2
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals (mg/kg, DW)											
Barium	1 / 1	321	321	0.7	(3)	NA		**459**	**459**	--	--
Beryllium	1 / 1	1.8	1.8	NA		NA		--	--	--	--
Cadmium	1 / 1	1.3	1.3	0.99	(1)	4.98	(a)	**1.3**	**1.3**	0.3	0.3
Chromium	1 / 1	130	130	43.4	(1)	111	(a)	**3.0**	**3.0**	**1.2**	**1.2**
Copper	1 / 1	87.6	87.6	31.6	(1)	149	(a)	**2.8**	**2.8**	0.6	0.6
Manganese	1 / 1	769	769	630	(3)	1100	(c)	**1.2**	**1.2**	0.7	0.7
Molybdenum	1 / 1	2.6	2.6	NA		NA		--	--	--	--
Nickel	1 / 1	45.4	45.4	22.7	(1)	48.6	(a)	**2.0**	**2.0**	0.9	0.9
Selenium	1 / 1	1.1	1.1	0.29	(3)	NA		**3.8**	**3.8**	--	--
Silver	0 / 1	0.5	0.5	0.5	(1)	3.7	(b)	1.0	1.0	0.1	0.1
Strontium	1 / 1	165	165	49.0	(3)	NA		**3.4**	**3.4**	--	--
Vanadium	1 / 1	148	148	50	(3)	NA		**3.0**	**3.0**	--	--
Zinc	1 / 1	131	131	121	(1)	459	(a)	**1.1**	**1.1**	0.3	0.3

COPECs - Chemicals of Potential Ecological Concern
mg/kg, DW = milligrams per kilogram, Dry Weight
NA - Not Available
HQ - Hazard Quotient
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.2
Hazard Quotients for Sediment COPECs in Reference Pond (Pond 1)
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals (mg/kg, DW)											
Barium	2 / 2	276	175	0.7	(3)	NA		**394**	**249**	--	--
Beryllium	1 / 2	1.8	1.2	NA		NA		--	--	--	--
Cadmium	1 / 2	0.80	0.98	0.99	(1)	4.98	(a)	0.8	1.0	0.2	0.2
Chromium	2 / 2	102	71.0	43.4	(1)	111	(a)	**2.4**	**1.6**	0.9	0.6
Cobalt	2 / 2	19.8	16.4	50	(1)	NA		0.4	0.3	--	--
Copper	2 / 2	86.6	65.3	31.6	(1)	149	(a)	**2.7**	**2.1**	0.6	0.4
Lead	2 / 2	26.4	17.0	35.8	(1)	128	(a)	0.7	0.5	0.2	0.1
Manganese	2 / 2	527	339	630	(3)	1100	(d)	0.8	0.5	0.5	0.3
Molybdenum	2 / 2	0.63	0.62	NA		NA		--	--	--	--
Nickel	2 / 2	35.6	30.3	22.7	(1)	48.6	(a)	**1.6**	**1.3**	0.7	0.6
Selenium	2 / 2	0.74	0.72	0.29	(3)	NA		**2.6**	**2.5**	--	--
Silver	0 / 2	0.58	0.83	0.5	(1)	3.7	(c)	**1.2**	**1.7**	0.2	0.2
Strontium	1 / 1	172	86.0	49	(3)	NA		**3.5**	**1.8**	--	--
Tin	1 / 2	3.0	2.1	5	(3)	NA		0.6	0.4	--	--
Vanadium	1 / 1	163	81.5	50	(3)	NA		**3.3**	**1.6**	--	--
Zinc	2 / 2	126	88.0	121	(1)	459	(a)	**1.0**	0.7	0.3	0.2

COPECs - Chemicals of Potential Ecological Concern
mg/kg, DW = milligrams per kilogram, Dry Weight
NA - Not Available
HQ - Hazard Quotient
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.3
Incremental Risk for Sediments in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	**459**	**459**	**394**	**249**	64.3	209	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	**1.3**	**1.3**	0.8	1.0	<1	<1	0.3	0.3	0.2	0.2	<1	<1
Chromium	**3.0**	**3.0**	**2.4**	**1.6**	<1	1	**1.2**	**1.2**	0.9	0.6	<1	<1
Copper	**2.8**	**2.8**	**2.7**	**2.1**	<1	<1	0.6	0.6	0.6	0.4	<1	<1
Manganese	**1.2**	**1.2**	0.8	0.5	<1	<1	0.7	0.7	0.5	0.3	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	**2.0**	**2.0**	**1.6**	**1.3**	<1	<1	0.9	0.9	0.7	0.6	<1	<1
Selenium	**3.8**	**3.8**	**2.6**	**2.5**	1.2	1	--	--	--	--	--	--
Silver	1.0	1.0	**1.2**	**1.7**	<1	<1	0.1	0.1	0.2	0.2	<1	<1
Strontium	**3.4**	**3.4**	**3.5**	**1.8**	<1	2	--	--	--	--	--	--
Vanadium	**3.0**	**3.0**	**3.3**	**1.6**	<1	1	--	--	--	--	--	--
Zinc	**1.1**	**1.1**	**1.0**	0.7	<1	<1	0.3	0.3	0.3	0.2	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area location.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.4
Hazard Quotients for Sediment COPECs in Pond 3
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals (mg/kg, DW)											
Barium	1 / 1	377	377	0.7	(3)	NA		**539**	**539**	--	--
Beryllium	1 / 1	1.6	1.6	NA		NA		--	--	--	--
Cadmium	1 / 1	1.2	1.2	0.99	(1)	4.98	(a)	**1.2**	**1.2**	0.2	0.2
Chromium	1 / 1	85	85	43.4	(1)	111	(a)	**2.0**	**2.0**	0.8	0.8
Copper	1 / 1	81.7	81.7	31.6	(1)	149	(a)	**2.6**	**2.6**	0.5	0.5
Lead	1 / 1	43.7	43.7	35.8	(1)	128	(a)	**1.2**	**1.2**	0.3	0.3
Manganese	1 / 1	3130	3130	630	(3)	1100	(c)	**5.0**	**5.0**	**2.8**	**2.8**
Molybdenum	1 / 1	2.2	2.2	NA		NA		--	--	--	--
Nickel	1 / 1	38.6	38.6	22.7	(1)	48.6	(a)	**1.7**	**1.7**	0.8	0.8
Selenium	1 / 1	1.4	1.4	0.29	(3)	NA		**4.8**	**4.8**	--	--
Silver	0 / 1	0.50	0.50	0.5	(1)	3.7	(b)	1.0	1.0	0.1	0.1
Strontium	1 / 1	134	134	49.0	(3)	NA		**2.7**	**2.7**	--	--
Vanadium	1 / 1	125	125	50	(3)	NA		**2.5**	**2.5**	--	--
Zinc	1 / 1	127	127	121	(1)	459	(a)	**1.0**	**1.0**	0.3	0.3

COPECs - Chemicals of Potential Ecological Concern
mg/kg, DW = milligrams per kilogram, Dry Weight
NA - Not Available
HQ - Hazard Quotient
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.5
Incremental Risk for Sediments in Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	**539**	**539**	**394**	**249**	**144**	**289**	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	**1.2**	**1.2**	0.8	1.0	<1	<1	0.2	0.2	0.2	0.2	<1	<1
Chromium	**2.0**	**2.0**	**2.4**	**1.6**	<1	<1	0.8	0.8	0.9	0.6	<1	<1
Copper	**2.6**	**2.6**	**2.7**	**2.1**	<1	<1	0.5	0.5	0.6	0.4	<1	<1
Lead	**1.2**	**1.2**	0.7	0.5	<1	<1	0.3	0.3	0.2	0.1	<1	<1
Manganese	**5.0**	**5.0**	0.8	0.5	**4.1**	**4.4**	**2.8**	**2.8**	0.5	0.3	**2.4**	**2.5**
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	**1.7**	**1.7**	**1.6**	**1.3**	<1	<1	0.8	0.8	0.7	0.6	<1	<1
Selenium	**4.8**	**4.8**	**2.6**	**2.5**	**2.3**	**2.3**	--	--	--	--	--	--
Silver	1.0	1.0	**1.2**	**1.7**	<1	<1	0.1	0.1	0.2	0.2	<1	<1
Strontium	**2.7**	**2.7**	**3.5**	**1.8**	<1	<1	--	--	--	--	--	--
Vanadium	**2.5**	**2.5**	**3.3**	**1.6**	<1	<1	--	--	--	--	--	--
Zinc	**1.0**	**1.0**	**1.0**	0.7	<1	<1	0.3	0.3	0.3	0.2	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area location.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.6
Hazard Quotients for Sediment COPECs in Pond 4
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals (mg/kg, DW)											
Barium	2 / 2	337	219	0.7	(3)	NA		**481**	**312**	--	--
Beryllium	1 / 2	1.6	1.1	NA		NA		--	--	--	--
Cadmium	2 / 2	2.5	1.8	0.99	(1)	4.98	(a)	**2.5**	**1.8**	0.5	0.4
Chromium	2 / 2	67	63.5	43.4	(1)	111	(a)	**1.5**	**1.5**	0.6	0.6
Copper	2 / 2	400	390	31.6	(1)	149	(a)	**12.7**	**12.3**	**2.7**	**2.6**
Manganese	2 / 2	2410	1665	630	(3)	1100	(c)	**3.8**	**2.6**	**2.2**	**1.5**
Molybdenum	2 / 2	1.8	1.4	NA		NA		--	--	--	--
Nickel	2 / 2	61.1	58.6	22.7	(1)	48.6	(a)	**2.7**	**2.6**	**1.3**	**1.2**
Selenium	2 / 2	1.3	1.00	0.29	(3)	NA		**4.5**	**3.4**	--	--
Silver	0 / 2	1.2	0.85	0.5	(1)	3.7	(b)	**2.4**	**1.7**	0.3	0.2
Strontium	1 / 1	91.9	46.0	49.0	(3)	NA		**1.9**	0.9	--	--
Thallium	0 / 1	1.2	0.60	NA		NA		--	--	--	--
Vanadium	2 / 2	93	75.5	50	(3)	NA		**1.9**	**1.5**	--	--
Zinc	2 / 2	320	318	121	(1)	459	(a)	**2.6**	**2.6**	0.7	0.7

COPECs - Chemicals of Potential Ecological Concern
mg/kg, DW = milligrams per kilogram, Dry Weight
NA - Not Available
HQ - Hazard Quotient
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.7
Incremental Risk for Sediments in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	481	312	394	249	87	63	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	2.5	1.8	0.8	1.0	1.7	<1	0.5	0.4	0.2	0.2	<1	<1
Chromium	1.5	1.5	2.4	1.6	<1	<1	0.6	0.6	0.9	0.6	<1	<1
Copper	13	12	2.7	2.1	9.9	10	2.7	2.6	0.6	0.4	2.1	2.2
Manganese	3.8	2.6	0.8	0.5	3.0	2.1	2.2	1.5	0.5	0.3	1.7	1.2
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	2.7	2.6	1.6	1.3	1.1	1.2	1.3	1.2	0.7	0.6	<1	<1
Selenium	4.5	3.4	2.6	2.5	1.9	<1	--	--	--	--	--	--
Silver	2.4	1.7	1.2	1.7	1.3	<1	0.3	0.2	0.2	0.2	<1	<1
Strontium	1.9	0.9	3.5	1.8	<1	<1	--	--	--	--	--	--
Thallium	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Vanadium	1.9	1.5	3.3	1.6	<1	<1	--	--	--	--	--	--
Zinc	2.6	2.6	1.0	0.7	1.6	1.9	0.7	0.7	0.3	0.2	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area location.

NA - Not Available - thallium was not analyzed for in Pond 1.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.8
Hazard Quotients for Sediment COPECs in Pond 5
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment	Source	Effect Sediment	Source	No Effect HQ RME	No Effect HQ CTE	Effect HQ RME	Effect HQ CTE
Metals (mg/kg, DW)											
Barium	1 / 1	296	296	0.7	(3)	NA		**423**	**423**	--	--
Beryllium	1 / 1	1.6	1.6	NA		NA		--	--	--	--
Cadmium	1 / 1	4	4	0.99	(1)	4.98	(a)	**4.0**	**4.0**	0.8	0.8
Chromium	1 / 1	70	70	43.4	(1)	111	(a)	**1.6**	**1.6**	0.6	0.6
Cobalt	1 / 1	78.3	78.3	50	(1)	NA		**1.6**	**1.6**	--	--
Copper	1 / 1	3540	3540	31.6	(1)	149	(a)	**112**	**112**	**24**	**24**
Manganese	1 / 1	1430	1430	630	(3)	1100	(c)	**2.3**	**2.3**	**1.3**	**1.3**
Molybdenum	1 / 1	2.5	2.5	NA		NA		--	--	--	--
Nickel	1 / 1	56.8	56.8	22.7	(1)	48.6	(a)	**2.5**	**2.5**	**1.2**	**1.2**
Selenium	1 / 1	1.3	1.3	0.29	(3)	NA		**4.5**	**4.5**	--	--
Silver	0 / 1	0.5	0.5	0.5	(1)	3.7	(b)	1.0	1.0	0.1	0.1
Strontium	1 / 1	76.5	76.5	49.0	(3)	NA		**1.6**	**1.6**	--	--
Tin	1 / 1	1.6	1.6	5.0	(3)	NA		0.3	0.3	--	--
Vanadium	1 / 1	79.0	79.0	50	(3)	NA		**1.6**	**1.6**	--	--
Zinc	1 / 1	507	507	121	(1)	459	(a)	**4.2**	**4.2**	**1.1**	**1.1**

COPECs - Chemicals of Potential Ecological Concern
mg/kg, DW = milligrams per kilogram, Dry Weight
NA - Not Available
HQ - Hazard Quotient
RME - Reasonable Maximum Exposure
CT - Central Tendency Exposure

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.9
Incremental Risk for Sediments in Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	**423**	**423**	**394**	**249**	**29**	**174**	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	**4.0**	**4.0**	0.8	1.0	**3.2**	**3.1**	0.8	0.8	0.2	0.2	<1	<1
Chromium	**1.6**	**1.6**	**2.4**	**1.6**	<1	<1	0.6	0.6	0.9	0.6	<1	<1
Cobalt	**1.6**	**1.6**	0.4	0.3	**1.2**	**1.2**	--	--	--	--	--	--
Copper	**112**	**112**	**2.7**	**2.1**	**109**	**110**	**24**	**24**	0.6	0.4	**23**	**23**
Manganese	**2.3**	**2.3**	0.8	0.5	**1.4**	**1.7**	**1.3**	**1.3**	0.5	0.3	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	**2.5**	**2.5**	**1.6**	**1.3**	<1	**1.2**	**1.2**	**1.2**	0.7	0.6	<1	<1
Selenium	**4.5**	**4.5**	**2.6**	**2.5**	**1.9**	**2.0**	--	--	--	--	--	--
Silver	1.0	1.0	**1.2**	**1.7**	<1	<1	0.1	0.1	0.2	0.2	<1	<1
Strontium	**1.6**	**1.6**	**3.5**	**1.8**	<1	<1	--	--	--	--	--	--
Tin	0.3	0.3	0.6	0.4	<1	<1	--	--	--	--	--	--
Vanadium	**1.6**	**1.6**	**3.3**	**1.6**	<1	<1	--	--	--	--	--	--
Zinc	**4.2**	**4.2**	**1.0**	0.7	**3.1**	**3.5**	**1.1**	**1.1**	0.3	0.2	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area location.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.10
Hazard Quotients for Sediment COPECs in the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals											
Barium	32 / 32	115	66.0	0.7	(3)	NA		**164**	**94**	--	--
Beryllium	7 / 32	2.0	0.62	NA		NA		--	--	--	--
Cadmium	9 / 12	3.2	1.5	0.99	(1)	4.98	(a)	**3.2**	**1.5**	0.6	0.3
Chromium	32 / 32	83.0	32.8	43.4	(1)	111	(a)	**1.9**	0.8	0.7	0.3
Cobalt	32 / 32	45.6	21.5	50	(1)	NA		0.9	0.4	--	--
Copper	32 / 32	3873	3101	31.6	(1)	149	(a)	**123**	**98**	**26**	**21**
Iron	32 / 32	141841	125288	188400	(3)	40000	(d)	0.8	0.7	**3.5**	**3.1**
Lead	30 / 32	40.2	29.3	35.8	(1)	128	(a)	**1.1**	0.8	0.3	0.2
Manganese	32 / 32	1249	298	630	(3)	1100	(d)	**2.0**	0.5	**1.1**	0.3
Molybdenum	30 / 30	12.7	10.9	NA		NA		--	--	--	--
Nickel	31 / 32	14.9	9.5	22.7	(1)	48.6	(a)	0.7	0.4	0.3	0.2
Selenium	30 / 30	31.8	28.5	0.29	(3)	NA		**110**	**98**	--	--
Silver	27 / 31	3.9	3.2	0.5	(1)	3.7	(c)	**7.8**	**6.4**	**1.0**	0.9
Strontium	6 / 6	123	88.0	49	(3)	NA		**2.5**	**1.8**	--	--
Thallium	7 / 26	3.3	5.3	NA		NA		--	--	--	--
Vanadium	32 / 32	69.6	61.0	50	(3)	NA		**1.4**	**1.2**	--	--
Zinc	32 / 32	132.3	110	121	(1)	459	(a)	**1.1**	0.9	0.3	0.2

COPECs - Chemicals of Potential Ecological Concern

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

HQ - Hazard Quotient

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.11
Hazard Quotients for Sediment COPECs in the Upstream Reference Section of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ RME	No Effect HQ CTE	Effect HQ RME	Effect HQ CTE
Metals											
Barium	13 / 13	159	106	0.7	(3)	NA		**227**	**151**	--	--
Beryllium	3 / 13	1.6	0.74	NA		NA		--	--	--	--
Cadmium	6 / 13	0.83	0.75	0.99	(1)	4.98	(a)	0.8	0.8	0.2	0.2
Chromium	13 / 13	46.8	38.5	43.4	(1)	111	(a)	**1.1**	0.9	0.4	0.3
Cobalt	13 / 13	17.3	14.4	50	(1)	NA		0.3	0.3	--	--
Copper	13 / 13	693	343	31.6	(1)	149	(a)	**22**	**11**	**4.6**	**2.3**
Iron	12 / 12	21035	16973	188400	(3)	40000	(c)	0.1	0.1	0.5	0.4
Lead	11 / 13	14.0	10.7	35.8	(1)	128	(a)	0.4	0.3	0.1	0.1
Manganese	13 / 13	1667	789	630	(3)	1100	(c)	**2.6**	**1.3**	**1.5**	0.7
Molybdenum	11 / 11	2.4	0.87	NA		NA		--	--	--	--
Nickel	13 / 13	27.1	22.8	22.7	(1)	48.6	(a)	**1.2**	**1.0**	0.6	0.5
Selenium	11 / 13	2.4	2.2	0.29	(3)	NA		**8.2**	**7.7**	--	--
Silver	0 / 13	2.1	0.96	0.5	(1)	3.7	(b)	**4.2**	**1.9**	0.6	0.3
Strontium	3 / 3	133	120	49	(3)	NA		**2.7**	**2.4**	--	--
Thallium	0 / 10	27.5	5.8	NA		NA		--	--	--	--
Vanadium	13 / 13	58.8	44.1	50	(3)	NA		**1.2**	0.9	--	--
Zinc	12 / 13	85.4	66.8	121	(1)	459	(a)	0.7	0.6	0.2	0.1

COPECs - Chemicals of Potential Ecological Concern
NA - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.12
Incremental Risk for Sediments in Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	RME	CTE	REF-RME	REF-CTE	RME	CTE	RME	CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	**164**	**94**	**227**	**151**	<1	<1	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	**3.2**	**1.5**	0.8	0.8	2.4	<1	0.6	0.3	0.2	0.2	<1	<1
Chromium	**1.9**	0.8	**1.1**	0.9	<1	<1	0.7	0.3	0.4	0.3	<1	<1
Cobalt	0.9	0.4	0.3	0.3	<1	<1	--	--	--	--	--	--
Copper	**123**	**98**	**22**	**11**	**101**	**87**	**26**	**21**	**4.6**	**2.3**	**21**	**19**
Iron	0.8	0.7	0.1	0.1	<1	<1	**3.5**	**3.1**	0.5	0.4	**3.0**	**2.7**
Lead	**1.1**	0.8	0.4	0.3	<1	<1	0.3	0.2	0.1	0.1	<1	<1
Manganese	**2.0**	0.5	**2.6**	**1.3**	<1	<1	**1.1**	0.3	**1.5**	0.7	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.7	0.4	**1.2**	**1.0**	<1	<1	0.3	0.2	0.6	0.5	<1	<1
Selenium	**110**	**98**	**8.2**	**7.7**	**101**	**91**	--	--	--	--	--	--
Silver	**7.8**	**6.4**	**4.2**	**1.9**	**3.6**	**4.5**	**1.0**	0.9	0.6	0.3	<1	<1
Strontium	**2.5**	**1.8**	**2.7**	**2.4**	<1	<1	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**1.4**	**1.2**	**1.2**	0.9	<1	<1	--	--	--	--	--	--
Zinc	**1.1**	0.9	0.7	0.6	<1	<1	0.3	0.2	0.2	0.1	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area location.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.13
Hazard Quotients for Sediment COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals, Total (mg/kg)											
Arsenic	31 / 34	2.8	2.0	9.79	(1)	33	(a)	0.3	0.2	0.1	0.1
Barium	34 / 34	106	62.1	0.7	(3)	NA		**152**	**89**	--	--
Beryllium	7 / 34	1.6	0.56	NA		NA		--	--	--	--
Chromium	34 / 34	23.3	19.8	43.4	(1)	111	(a)	0.5	0.5	0.2	0.2
Cobalt	34 / 34	24.7	13.5	50	(1)	NA		0.5	0.3	--	--
Copper	34 / 34	489	300	31.6	(1)	149	(a)	**15**	**9.5**	**3.3**	**2.0**
Manganese	34 / 34	655	442	630	(3)	1100	(c)	**1.0**	0.7	0.6	0.4
Molybdenum	29 / 30	2.3	1.22	NA		NA		--	--	--	--
Selenium	29 / 33	2.8	2.34	0.29	(3)	NA		**9.5**	**8.1**	--	--
Strontium	6 / 6	212	194	49.0	(3)	NA		**4.3**	**4.0**	--	--
Vanadium	34 / 35	34.3	23.5	50	(3)	NA		0.7	0.5	--	--
Zinc	34 / 34	64.3	57.4	121	(1)	459	(a)	0.5	0.5	0.1	0.1

COPECs - Chemicals of Potential Ecological Concern
mg/kg = milligrams per kilogram
NA - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 1
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.14
Hazard Quotients for Sediment COPECs in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ RME	No Effect HQ CTE	Effect HQ RME	Effect HQ CTE
Metals, Total (mg/kg)											
Arsenic	8 / 12	3.0	2.2	9.79	(1)	33	(a)	0.3	0.2	0.1	0.1
Barium	11 / 11	148	64.7	0.7	(3)	NA		**212**	**92**	--	--
Beryllium	3 / 11	2	0.60	NA		NA		--	--	--	--
Chromium	11 / 11	52.0	23.1	43.4	(1)	111	(a)	**1.2**	0.5	0.5	0.2
Cobalt	11 / 11	6.0	5.0	50	(1)	NA		0.1	0.1	--	--
Copper	11 / 11	14.6	10.5	31.6	(1)	149	(a)	0.5	0.3	0.1	0.1
Manganese	11 / 11	599	442	630	(3)	1100	(c)	0.95	0.7	0.5	0.4
Molybdenum	5 / 7	0.28	0.55	NA		NA		--	--	--	--
Selenium	1 / 5	0.30	0.70	0.29	(3)	NA		**1.0**	**2.4**	--	--
Strontium	2 / 2	257	230	49.0	(3)	NA		**5.2**	**4.7**	--	--
Vanadium	11 / 11	29.7	21.5	50	(3)	NA		0.6	0.4	--	--
Zinc	11 / 11	40.1	28.8	121	(1)	459	(a)	0.3	0.2	0.1	0.1

mg/kg = milligrams per kilogram
NA - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.15
Incremental Risk for Sediments in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Arsenic	0.3	0.2	0.3	0.2	<1	<1	0.1	0.1	0.1	0.1	<1	<1
Barium	**152**	**89**	**212**	**92**	<1	<1	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	0.5	0.5	**1.2**	0.5	<1	<1	0.2	0.2	0.5	0.2	<1	<1
Cobalt	0.5	0.3	0.1	0.1	<1	<1	--	--	--	--	--	--
Copper	**15**	**9.5**	0.5	0.3	**15**	**9.2**	**3.3**	**2.0**	0.1	0.1	**3.2**	**1.9**
Manganese	**1**	0.7	0.95	0.7	<1	<1	0.6	0.4	0.5	0.4	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	**9.5**	**8.1**	**1.0**	**2.4**	**8.5**	**5.6**	--	--	--	--	--	--
Strontium	**4.3**	**4.0**	**5.2**	**4.7**	<1	<1	--	--	--	--	--	--
Vanadium	0.7	0.5	0.6	0.4	<1	<1	--	--	--	--	--	--
Zinc	0.5	0.5	0.3	0.2	<1	<1	0.1	0.1	0.1	0.1	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

-- - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.16
Hazard Quotients for Sediment COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ		Effect HQ	
								RME	CTE	RME	CTE
Metals, Total (mg/kg)											
Barium	17 / 17	90.0	46.3	0.7	(3)	NA		**129**	**66**	--	--
Beryllium	4 / 17	1.8	0.40	NA		NA		--	--	--	--
Copper	17 / 17	127	76.3	31.6	(1)	149	(a)	**4.0**	**2.4**	0.9	0.5
Manganese	17 / 17	475	355	630	(3)	1100	(c)	0.8	0.6	0.4	0.3
Molybdenum	8 / 10	1.1	0.92	NA		NA		--	--	--	--
Selenium	3 / 17	0.81	1.6	0.29	(3)	NA		**2.8**	**5.6**	--	--
Silver	2 / 17	0.57	0.72	0.5	(1)	3.7	(c)	**1.1**	**1.4**	0.2	0.2
Strontium	1 / 1	193	193	49.0	(3)	NA		**3.9**	**3.9**	--	--
Thallium	0 / 16	13.8	4.5	NA		NA		--	--	--	--
Zinc	17 / 17	58.7	44	121	(1)	459	(a)	0.5	0.4	0.1	0.1

mg/kg = milligrams per kilogram

NA - Not Available

COPECs - Chemicals of Potential Ecological Concern

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

HQ - Hazard Quotient

EBOR – East Branch of the Ompompanoosuc River

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.17
Hazard Quotients for Sediment COPECs in the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	RME	CTE	No Effect Sediment Benchmark	Source	Effect Sediment Benchmark	Source	No Effect HQ RME	No Effect HQ CTE	Effect HQ RME	Effect HQ CTE
Metals, Total (mg/kg)											
Barium	3 / 3	187	79.4	0.7	(3)	NA		**267**	**113**	--	--
Beryllium	2 / 3	1.6	0.75	NA		NA		--	--	--	--
Copper	2 / 3	4.5	3.2	31.6	(1)	149	(a)	0.1	0.1	0.03	0.02
Manganese	3 / 3	475	278	630	(3)	1100	(d)	0.8	0.4	0.4	0.3
Molybdenum	1 / 1	0.16	0.16	NA		NA		--	--	--	--
Selenium	0 / 3	5.0	1.8	0.29	(3)	NA		**17**	**6.2**	--	--
Silver	1 / 3	0.28	0.76	0.5	(1)	3.7	(c)	0.6	**1.5**	0.1	0.2
Strontium	1 / 1	198	198	49.0	(3)	NA		**4.0**	**4.0**	--	--
Thallium	0 / 2	17.5	9.1	NA		NA		--	--	--	--
Zinc	3 / 3	33.0	22.2	121	(1)	459	(a)	0.3	0.2	0.1	0.05

mg/kg = milligrams per kilogram
NA - Not Available
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
EBOR – East Branch of the Ompompanoosuc River

1. USEPA. 2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
2. Jones, D.S., G.W. Suter and R.N. Hull. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. Oak Ridge National Laboratory. ES/ER/TM-95/R4.
3. Buchman, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, National Oceanic and Atmospheric Administration. 12 pp.
4. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

a. MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.
b. Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Manag. 19:81-97.
c. Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy.

Attachment 7.18
Incremental Risk for Sediments in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Barium	**129**	**66**	**267**	**113**	<1	<1	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Copper	**4.0**	**2.4**	0.1	0.1	**3.9**	**2.3**	0.9	0.5	0.03	0.02	<1	<1
Manganese	0.8	0.6	0.8	0.4	<1	<1	0.4	0.3	0.4	0.3	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	**2.8**	**5.6**	**17**	**6.2**	<1	<1	--	--	--	--	--	--
Silver	**1.1**	**1.4**	0.6	**1.5**	<1	<1	0.2	0.2	0.1	0.2	<1	<1
Strontium	**3.9**	**3.9**	**4.0**	**4.0**	<1	<1	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	0.5	0.4	0.3	0.2	<1	<1	0.1	0.1	0.1	0.05	<1	<1

COPECs - Chemicals of Potential Ecological Concern
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
-- - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

Attachment 7.19
Hazard Quotients for Pore Water COPECs in Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	6 / 6	456	95.1	750	(a)	87	(1)	0.6	0.1	**5.2**	**1.1**
Arsenic	0 / 6	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 6	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Cadmium	6 / 6	2.0	0.45	2	(a)	0.25	(1)	1.0	0.2	**7.8**	**1.8**
Cobalt	6 / 6	95.0	32.5	1500	(c)	24	(4)	0.1	0.0	**4.0**	**1.4**
Copper	6 / 6	131	45.6	13.0	(a)	9	(1)	**10**	**3.5**	**15**	**5.1**
Manganese	6 / 6	6590	1782	2300	(c)	120	(6)	**3**	0.8	**55**	**15**
Mercury	0 / 2	2.5	2.5	1.4	(a)	0.77	(1)	**1.8**	**1.8**	**3.2**	**3.2**
Strontium	6 / 6	212	97.5	15000	(c)	1500	(6)	0.01	0.01	0.1	0.1
Zinc	6 / 6	126	31.6	120	(a)	120	(1)	**1.1**	0.3	**1.1**	0.3

ug/L - micorgrams per liter
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.20
Hazard Quotients for Pore Water COPECs in the Upstream Reference Section of the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	3 / 3	88.8	35.1	750	(a)	87	(1)	0.1	0.05	**1.0**	0.4
Arsenic	0 / 3	100	100	340	(a)	150	(1)	0.3	0.29	0.7	0.7
Beryllium	0 / 3	5.0	5.0	35	(c)	3.6	(4)	0.1	0.14	**1.4**	**1.4**
Cadmium	2 / 3	0.73	2.2	2	(a)	0.25	(1)	0.4	**1.1**	**2.9**	**8.6**
Cobalt	2 / 3	0.55	2.0	1500	(c)	24	(4)	0.0	0.00	0.0	0.1
Copper	3 / 3	6.2	3.6	13.0	(a)	9	(1)	0.5	0.28	0.7	0.4
Manganese	3 / 3	3000	1019	2300	(c)	120	(6)	**1.3**	0.44	**25**	**8.5**
Mercury	0 / 1	2.5	2.5	1.4	(a)	0.77	(1)	**1.8**	**1.8**	**3.2**	**3.2**
Strontium	3 / 3	258	133	15000	(c)	1500	(6)	0.0	0.01	0.2	0.1
Zinc	3 / 3	12.8	5.6	120	(a)	120	(1)	0.1	0.05	0.1	0.0

ug/L - micorgrams per liter
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.21
Incremental Risk for the Pore Water in the
Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPECs	**Site-RME**	**Site-CTE**	**REF-RME**	**REF-CTE**	**RME**	**CTE**	**Site-RME**	**Site-CTE**	**REF-RME**	**REF-CTE**	**RME**	**CTE**
Metals												
Aluminum	0.6	0.1	0.1	0.05	<1	<1	**5.2**	**1.1**	**1.0**	0.4	**4.2**	<1
Arsenic	0.3	0.3	0.3	0.3	<1	<1	0.7	0.7	0.7	0.7	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.4**	**1.4**	**1.4**	<1	<1
Cadmium	1.0	0.2	0.4	**1.1**	<1	<1	**7.8**	**1.8**	**2.9**	**8.6**	**4.9**	<1
Cobalt	0.1	0.02	0.0004	0.001	<1	<1	**4.0**	**1.4**	0.02	0.1	**3.9**	**1.3**
Copper	**10**	**3.5**	0.5	0.3	**10**	**3.2**	**15**	**5.1**	0.7	0.4	**14**	**4.7**
Manganese	**3**	1	**1**	0.4	**1.6**	<1	**55**	**15**	**25**	**8.5**	**30**	**6.4**
Mercury	**1.8**	**1.8**	**1.8**	**1.8**	<1	<1	**3.2**	**3.2**	**3.2**	**3.2**	<1	<1
Strontium	0.01	0.01	0.02	0.01	<1	<1	0.1	0.1	0.2	0.1	<1	<1
Zinc	**1.1**	0.3	0.1	0.05	<1	<1	**1.1**	0.3	0.1	0.05	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.22
Hazard Quotients for Pore Water COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	9 / 9	202	44.0	750	(a)	87	(1)	0.3	0.1	**2.3**	0.5
Arsenic	0 / 9	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 9	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Cadmium	9 / 9	0.30	0.11	2	(a)	0.25	(1)	0.2	0.1	**1.2**	0.4
Copper	9 / 9	25.0	8.8	13.0	(a)	9	(1)	**1.9**	0.7	**2.8**	0.98
Manganese	9 / 9	2030	589.1	2300	(c)	120	(6)	0.9	0.3	**17**	**4.9**
Selenium	8 / 9	7.4	4.3	20	(b)	5.0	(1)	0.4	0.2	**1.5**	0.9
Thallium	7 / 9	470	266.3	110	(c)	40	(5)	**4.3**	**2.4**	**12**	**6.7**
Zinc	2 / 9	149	19.1	120	(a)	120	(1)	**1.2**	0.2	**1.2**	0.2

ug/L - micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

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b. State of Vermont. 2006. Vermont Water Quality Standards.
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Attachment 7.23
Hazard Quotients for Pore Water COPECs in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	3 / 3	98.0	40.1	750	(a)	87	(1)	0.1	0.05	**1.1**	0.5
Arsenic	0 / 3	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 3	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Cadmium	2 / 5	0.02	0.84	2	(a)	0.25	(1)	0.01	0.4	0.1	**3.4**
Copper	2 / 5	0.58	1.9	13.0	(a)	9	(1)	0.04	0.1	0.1	0.2
Manganese	3 / 3	4000	1336	2300	(c)	120	(6)	**1.7**	0.6	**33**	**11**
Selenium	0 / 3	0.50	0.50	20	(b)	5	(1)	0.03	0.03	0.1	0.1
Thallium	1 / 3	0.20	0.10	110	(c)	40	(5)	0.002	0.001	0.01	0.003
Zinc	3 / 5	2.2	1.4	120.0	(a)	120	(1)	0.02	0.01	0.02	0.01

ug/L - micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

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2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

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b. State of Vermont. 2006. Vermont Water Quality Standards.
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Attachment 7.24
Incremental Risk for the Pore Water in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPECs	**RME**	**CTE**	**REF-RME**	**REF-CTE**	**RME**	**CTE**	**RME**	**CTE**	**REF-RME**	**REF-CTE**	**RME**	**CTE**
Metals												
Aluminum	0.3	0.1	0.1	0.1	<1	<1	**2.3**	0.5	**1.1**	0.5	**1.2**	<1
Arsenic	0.3	0.3	0.3	0.3	<1	<1	0.7	0.7	0.7	0.7	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.4**	**1.4**	**1.4**	<1	<1
Cadmium	0.2	0.1	0.01	0.4	<1	<1	**1.2**	0.4	0.10	**3.4**	**1.1**	<1
Copper	**1.9**	0.7	0.04	0.1	**1.9**	<1	**2.8**	1.0	0.06	0.2	**2.7**	<1
Manganese	0.9	0.3	**1.7**	0.6	<1	<1	**17**	**4.9**	**33**	**11**	<1	<1
Selenium	0.4	0.2	0.03	0.03	<1	<1	**1.5**	0.9	0.1	0.1	**1.4**	<1
Thallium	**4.3**	**2.4**	0.002	0.001	**4.3**	**2.4**	**12**	**6.7**	0.005	0.003	**12**	**6.7**
Zinc	**1.2**	0.2	0.02	0.01	**1.2**	<1	**1.2**	0.2	0.02	0.01	**1.2**	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.25
Hazard Quotients for Pore Water COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Arsenic	0 / 3	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 3	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Manganese	3 / 3	3700	1918	2300	(c)	120	(6)	**1.6**	0.8	**31**	**16**
Mercury	0 / 1	2.5	2.5	1.4	(a)	0.77	(1)	**1.8**	**1.8**	**3.2**	**3.2**

ug/L - micorgrams per liter
EBOR - East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

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b. State of Vermont. 2006. Vermont Water Quality Standards.
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Attachment 7.26
Hazard Quotients for Pore Water in the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Arsenic	0 / 3	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 3	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Manganese	2 / 3	6830	2347	2300	(c)	120	(6)	**3.0**	**1.0**	**57**	**20**
Mercury	0 / 1	2.5	2.5	1.4	(a)	0.77	(1)	**1.8**	**1.8**	**3.2**	**3.2**

ug/L - micrograms per liter
EBOR - East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.27
Incremental Risk for Pore Water in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Arsenic	0.3	0.3	0.3	0.3	<1	<1	0.7	0.7	0.7	0.7	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.4**	**1.4**	**1.4**	<1	<1
Manganese	**1.6**	0.8	**3.0**	**1.0**	<1	<1	**31**	**16**	**57**	**20**	<1	<1
Mercury	**1.8**	**1.8**	**1.8**	**1.8**	<1	<1	**3.2**	**3.2**	**3.2**	**3.2**	<1	<1

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

Calculation of AVS-SEM
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

				Sampling	Cadmium			Copper			Lead			Mercury			Nickel			Silver			Zinc			SEM	Acid Volatile Sulfide		AVS			SEM-AVS
Site Name	Sample Name	Exposure Area	Units	Date	conc	RL	qual	conc	RL	qual	conc	RL	qual	conc	RL	qual	conc	RL	qual	conc	RL	qual	conc	RL	qual				conc	RL	qual	
EB-210M	ELY-SED-10C	Ely Brook	umole/g	11/3/2004	0.002	0.002	J	3.0			0.03						1.0			0.01			0.10			4.1			ND	0.06		131
EB-30M	ELY-SED-09C	Ely Brook	umole/g	11/3/2004	0.002	0.002	J	3.6			0.04						0.01	0.02	J	0.01			0.18			3.9			ND	0.07		113
EB-405M	ELY-SED-33C	Ely Brook	umole/g	11/3/2004	0.003			5.2			0.03						0.33			0.01			0.14			5.7			ND	0.07		176
EB-440M	ELY-SED-11C	Ely Brook	umole/g	11/3/2004	0.002	0.002	J	2.9			0.03						1.4			0.01			0.10			4.4			ND	0.06		139
EB-530M	ELY-SED-12C	Ely Brook	umole/g	11/1/2004	0.003			1.5			0.02						0.26			0.01	0.006	J	0.06			1.9			ND	0.06		59
EB-560M	ELY-SED-13C	Ely Brook	umole/g	11/1/2004	0.003			14.2			0.02						1.2			0.003	0.006	J	0.53			16.0			ND	0.06		506
EB-600M	06ELY03	Ely Brook	umole/g	8/23/2006	0.004		B	13.8			0.02			ND	0.0008		0.06		B				0.65			14.5	ND	10.1	ND	0.61		48
EB-770M	06ELY02	Ely Brook	umole/g	8/23/2006	0.001		B	5.4			0.01		B	ND	0.0008		0.04		B				0.30			5.7	ND	10.5	ND	0.64		18.0
EB-90M	06ELY04	Ely Brook	umole/g	8/23/2006	ND	0.001		1.1			0.02			ND	0.0008		ND	0.01					0.05		B	1.2	ND	10.2	ND	0.63		3.7
SB-1360M	06ELY07	School House Brook	umole/g	8/23/2006	ND	0.001		1.0			0.01		B	ND	0.0008		0.04		B				0.30			1.4	ND	10.3	ND	0.65		4.2
SB-1360M	ELY-SED-01C	School House Brook	umole/g	11/3/2004	0.002	0.002	J	2.1	0.005	J	0.01						0.07	0.02	J	0.0004	0.006	J	0.66			2.9			0.33	0.06	J	8.6
SB-140M	06ELY08	School House Brook	umole/g	8/22/2006	ND	0.001		1.2			0.02		B	ND	0.0009		0.04		B				0.35			1.6	ND	10.8	ND	0.66		4.9
SB-20M	ELY-SED-27C	School House Brook	umole/g	11/4/2004	0.002			2.5	0.005	J	0.02						0.08	0.02	J	0.0004	0.006	J	0.67			3.3			0.17	0.06	J	19
SB-2400M	06ELY06	School House Brook	umole/g	8/22/2006	ND	0.001		1.0			0.01		B	ND	0.0008		0.04		B				0.30			1.3	ND	10.3	ND	0.64		4.2
SB-2900M	ELY-SED-02C	School House Brook	umole/g	11/4/2004	0.002	0.002	J	2.0	0.005	J	0.01						0.07	0.02	J	0.0005	0.006	J	0.44			2.5			ND	0.06	UJ	83
SB-2920M	ELY-SED-03C	School House Brook	umole/g	11/4/2004	0.002	0.002	J	2.3	0.005	J	0.01						0.53	0.02	J	0.0004	0.005	J	0.44			3.3			ND	0.06	UJ	109
SB-3020M	ELY-SED-04C	School House Brook	umole/g	11/4/2004	0.001	0.002	J	1.6	0.004	J	0.01						0.05	0.02	J	0.0005	0.005	J	0.34			2.0			ND	0.06	UJ	67
SB-3125M	ELY-SED-05C	School House Brook	umole/g	11/4/2004	0.001	0.002	J	1.8	0.005	J	0.01						0.05	0.02	J	0.0004	0.005	J	0.32			2.1			ND	0.06	UJ	74
SB-3250M	ELY-SED-06C	School House Brook	umole/g	11/4/2004	0.002			3.0	0.004	J	0.02						1.1	0.02	J	0.0008	0.005	J	0.55			4.7			0.11	0.06	J	42
OR-11850M	SED-03-35R	EBOR	umole/g	7/19/2000	0.003			1.0			0.03						0.13						0.56			1.7			ND	0.18		19.1
OR-23200M	06ELY10	EBOR	umole/g	8/22/2006	ND	0.001		0.27			0.01		B	ND	0.0009		0.03		B				0.14			0.44	ND	11.5	ND	0.68		1.3
OR-23630M	ELY-SED-28C	EBOR	umole/g	11/4/2004	0.0007	0.002	J	0.52	0.005	J	0.02						0.05	0.02	J	ND	0.005		0.27			0.85			0.11	0.06	J	7.8
OR-23650M	ELY-SED-26C	EBOR	umole/g	11/4/2004	0.0004	0.002	J	0.08	0.005	J	0.01						0.13	0.02	J	ND	0.006		0.15			0.37			0.28	0.06	J	1.3
OR-8350M	SED-04-45R	EBOR	umole/g	10/2/2000	ND	0.004		0.26			ND	0.04					ND	0.07					0.25			0.51			0.25			2.0

umole/g - micromile per gram

Note: Most AVS concentrations fell below their RLs. In those situations, the SEM/AVS was obtained by dividing the SEM concentration by one half of the RL.

Note 2: Only on sample collected for SEM and AVS analysis was analyzed for total organic carbon (TOC).

EBOR - East Branch of the Ompompanoosuc River

SEM - Simultaneously Extracted Metals

AVS - Acid Volatile Sulfide

Conc - concentration

RL - Reporting Limit

Qual - qualifier

ND - Not Detected

B - analyte is associated with blank contamination

J - estimated value

Attachment 7.29: Weight-of-Evidence Integration for Benthic Invertebrates
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 1:
Maintain a stable and healthy benthic invertebrate community
Are the COPEC levels in sediment sufficiently high to cause biologically-significant changes or impair the function of the benthic community in the on-Site ponds and the three streams affected by Ely Mine?

Measurement Endpoints
1.A: Compare COPEC levels in sediment samples to published sediment benchmarks
1.B: Compare dissolved COPEC levels in pore water samples to published surface water benchmarks
1.C: Estimate the bioavailability of divalent metals in sediment based on SEM/AVS
1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours to sediment pore water samples
1.E: Measure survival and growth in *H. azteca* and *C. tentans* exposed for 10 days and 28 days, respectively, to bulk sediment samples
1.F: Evaluate the structure and function of the benthic invertebrate community

Weight-of-Evidence Integration

Pond 2 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm	**1.A**				

Pond 3 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**1.A**				
Undeterminate					
No Harm					

Pond 4 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**1.A**				
Undeterminate					
No Harm					

Pond 5 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**1.A**				
Yes/Low					
Undeterminate					
No Harm					

Attachment 7.29: Weight-of-Evidence Integration for Benthic Invertebrates
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

The main stem of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**1.A; 1.B; 1C**		**1.D**	**1.E**	**1.F**
Yes/Low					
Undeterminate					
No Harm					

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**1.B; 1C**			**1.E**	**1.F**
Yes/Low	**1.A**				
Undeterminate					
No Harm			**1.D**		

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**1.C**				
Undeterminate					
No Harm	**1.A; 1.B**		**1.D**	**1.E**	**1.F**

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the benthic invertebrate community is discussed in Section 7 of the BERA

Attachment 7.30
Hazard Quotients for Surface Water COPECs in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Beryllium	0 / 6	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Copper	6 / 6	41.8	10.6	13.0	(a)	9	(1)	**3.2**	0.8	**4.6**	**1.2**
Manganese	6 / 6	1400	533	2300	(c)	120	(6)	0.6	0.2	**12**	**4.4**
Silver	3 / 6	0.49	6.7	3.2	(a)	0.32	(1)	0.2	**2.1**	**1.5**	**21**
Zinc	6 / 6	171	66.8	120	(a)	120	(1)	**1.4**	0.6	**1.4**	0.6

COPECs - Chemicals of Potential Ecological Concern
ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CTE- Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.31
Hazard Quotients for Surface Water COPECs in Reference Pond (Pond 1)
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Arsenic	1 / 8	0.13	20.8	340	(a)	87	(1)	0.0004	0.06	0.001	0.24
Beryllium	0 / 8	5.0	4.1	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.1**
Cadmium	0 / 8	22.9	17.0	2	(a)	0.25	(1)	**11**	**8.5**	**91**	**68**
Chromium	1 / 8	0.60	38.7	16	(a)	11	(1)	0.04	**2.4**	0.05	**3.5**
Cobalt	2 / 8	0.06	8.26	1500	(c)	24	(4)	0.00004	0.006	0.003	0.3
Copper	2 / 8	4.6	39.2	13.0	(a)	9.0	(1)	0.4	**3.0**	0.5	**4.4**
Lead	2 / 8	0.75	82.3	65	(a)	2.5	(1)	0.01	**1.3**	0.3	**33**
Manganese	2 / 8	10.1	9.9	2300	(c)	120	(6)	0.004	0.004	0.1	0.1
Selenium	0 / 8	22.5	11.3	20.0	(b)	5	(1)	**1.1**	0.6	**4.5**	**2.3**
Silver	0 / 8	150	97.8	3.2	(a)	0.32	(1)	**47**	**31**	**469**	**306**
Thallium	0 / 8	22.5	11.2	110	(c)	40	(5)	0.2	0.1	0.6	0.3
Zinc	5 / 8	199	92.8	120	(a)	120	(1)	**1.7**	0.8	**1.7**	0.8

COPECs - Chemicals of Potential Ecological Concern
ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.32
Incremental Risk for Surface Water in Pond 2
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.4**	**1.4**	**1.1**	<1	<1
Copper	**3.2**	0.8	0.4	**3.0**	**2.9**	<1	**4.6**	**1.2**	0.5	**4.4**	**4.1**	<1
Manganese	0.6	0.2	0.004	0.004	<1	<1	**11.7**	**4.4**	0.08	0.08	**12**	**4.4**
Silver	0.2	**2.1**	**47**	**31**	<1	<1	**1.5**	**21**	**469**	**306**	<1	<1
Zinc	**1.4**	0.6	**1.7**	0.8	<1	<1	**1.4**	0.6	**1.7**	0.8	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.33
Hazard Quotients for Surface Water COPECs in Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Arsenic	0 / 1	100	100	340	(a)	150	(1)	0.3	0.3	0.7	0.7
Beryllium	0 / 1	5.0	5.0	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.4**
Cadmium	0 / 1	6.5	6.5	2	(a)	0	(1)	**3**	**3**	**26**	**26**
Chromium	0 / 1	14.4	14.4	16	(a)	11	(1)	0.9	0.9	**1.3**	**1.3**
Manganese	1 / 1	444	444	2300	(c)	120	(6)	0.2	0.2	**3.7**	**3.7**
Silver	1 / 1	46.2	46.2	3.2	(a)	0.32	(1)	**14**	**14**	**144**	**144**

COPECs - Chemicals of Potential Ecological Concern
ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CT - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.34
Incremental Risk for Surface Water from Pond 3
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Arsenic	0.3	0.3	0.0004	0.1	<1	<1	0.7	0.7	0.001	0.2	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.4**	**1.4**	**1.1**	<1	<1
Cadmium	**3.3**	**3.3**	**11**	**8**	<1	<1	**26**	**26**	**91**	**68**	<1	<1
Chromium	0.9	0.9	0.04	**2.4**	<1	<1	**1.3**	**1.3**	0.05	**3.5**	**1.3**	<1
Manganese	0.2	0.2	0.004	0.004	<1	<1	**3.7**	**3.7**	0.08	0.08	**3.6**	**3.6**
Silver	**14**	**14**	**47**	**31**	<1	<1	**144**	**144**	**469**	**306**	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.35
Hazard Quotients for Surface Water COPECs in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ RME	Acute HQ CTE	Chronic HQ RME	Chronic HQ CTE
Metals, Dissolved (ug/L)											
Arsenic	0 / 8	100	20.8	340	(a)	150	(1)	0.3	0.1	0.7	0.1
Beryllium	0 / 9	5.0	3.6	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.0**
Copper	8 / 10	64.0	29.6	13.0	(a)	9	(1)	**4.9**	**2.3**	**7.1**	**3.3**
Manganese	10 / 10	212	98.3	2300	(c)	120	(6)	0.1	0.0	**1.8**	0.82
Selenium	0 / 10	22.5	9.1	20.0	(b)	5	(1)	**1.1**	0.5	**4.5**	**1.8**
Silver	0 / 10	109	48.6	3.2	(a)	0.32	(1)	**34**	**15**	**341**	**152**
Thallium	0 / 10	22.5	9.0	110	(c)	40	(5)	0.2	0.1	0.6	0.2
Zinc	8 / 10	186	89.9	120	(a)	120	(1)	**1.5**	0.7	**1.5**	0.7

COPECs - Chemicals of Potential Ecological Concern
ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CT - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.36
Incremental Risk for Surface Water in Pond 4
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Arsenic	0.3	0.1	0.0004	0.1	<1	<1	0.7	0.1	0.001	0.2	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.0**	**1.4**	**1.1**	<1	<1
Copper	**4.9**	**2.3**	0.4	**3.0**	**4.6**	<1	**7.1**	**3.3**	0.5	**4.4**	**6.6**	<1
Manganese	0.1	0.04	0.004	0.004	<1	<1	**1.8**	0.82	0.08	0.08	**1.7**	<1
Selenium	**1.1**	0.5	**1.1**	0.6	<1	<1	**4.5**	**1.8**	**4.5**	**2.3**	<1	<1
Silver	**34**	**15**	**47**	**31**	<1	<1	**341**	**152**	**469**	**306**	<1	<1
Thallium	0.2	0.1	0.2	0.1	<1	<1	0.6	0.2	0.6	0.3	<1	<1
Zinc	**1.5**	0.7	**1.7**	0.8	<1	<1	**1.5**	0.7	**1.7**	0.8	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

NA - Not Available

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Created by: RAR 5/22/2008
Qc'd by: EK 5/27/2008

Attachment 7.37
Hazard Quotients for Surface Water COPECs in Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Arsenic	0 / 4	100	33.3	340	(a)	150	(1)	0.3	0.1	0.7	0.2
Beryllium	0 / 4	5.0	4.6	35	(c)	3.6	(4)	0.1	0.1	**1.4**	**1.3**
Cadmium	1 / 4	1.9	11.1	2	(a)	0.25	(1)	1.0	**5.6**	**7.7**	**44.5**
Chromium	0 / 4	35.3	26.1	16	(a)	11	(1)	**2.2**	**1.6**	**3.2**	**2.4**
Cobalt	1 / 4	24.0	14.3	1500	(c)	24	(4)	0.02	0.01	1.0	0.6
Copper	4 / 4	670	446	13.0	(a)	9	(1)	**52**	**34**	**74**	**50**
Lead	0 / 4	74.3	61.1	65	(a)	2.5	(1)	**1.1**	0.9	**29.7**	**24.4**
Manganese	4 / 4	425	194	2300	(c)	120	(6)	0.2	0.1	**3.5**	**1.6**
Selenium	0 / 4	11.0	8.4	20.0	(b)	5	(1)	0.6	0.4	**2.2**	**1.7**
Silver	0 / 4	63.7	41.0	3.2	(a)	0.32	(1)	**20**	**13**	**199**	**128**
Thallium	0 / 4	22.5	11.1	110	(c)	40	(5)	0.2	0.1	0.6	0.3
Zinc	4 / 4	376	318	120	(a)	120	(1)	**3.1**	**2.6**	**3.1**	**2.6**

COPECs - Chemicals of Potential Ecological Concern
ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CT - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.38
Incremental Risk for Surface Water from Pond 5
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Arsenic	0.3	0.1	0.0004	0.1	<1	<1	0.7	0.2	0.001	0.2	<1	<1
Beryllium	0.1	0.1	0.1	0.1	<1	<1	**1.4**	**1.3**	**1.4**	**1.1**	<1	<1
Cadmium	1.0	**5.6**	**11**	**8.5**	<1	<1	**7.7**	**45**	**91**	**68**	<1	<1
Chromium	**2.2**	**1.6**	0.04	**2.4**	**2.2**	<1	**3.2**	**2.4**	0.05	**3.5**	**3.2**	<1
Cobalt	0.02	0.01	0.00004	0.01	<1	<1	1.0	0.6	0.003	0.3	<1	<1
Copper	**52**	**34**	0.4	**3.0**	**51**	**31**	**74**	**50**	0.5	**4.4**	**74**	**45**
Lead	**1.1**	0.9	0.01	**1**	**1**	<1	**30**	**24**	0.30	**33**	**29.4**	<1
Manganese	0.2	0.1	0.004	0.004	<1	<1	**3.5**	**1.6**	0.08	0.08	**3.5**	**1.5**
Selenium	0.6	0.4	**1.1**	0.6	<1	<1	**2.2**	**1.7**	**4.5**	**2.3**	<1	<1
Silver	**20**	**13**	**47**	**31**	<1	<1	**199**	**128**	**469**	**306**	<1	<1
Thallium	0.2	0.1	0.2	0.1	<1	<1	0.6	0.3	0.6	0.3	<1	<1
Zinc	**3.1**	**2.6**	**1.7**	0.8	**1.5**	**1.9**	**3.1**	**2.6**	**1.7**	0.8	**1.5**	**1.9**

COPECs - Chemicals of Potential Ecological Concern
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
NA - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

Attachment 7.39: Weight-of-Evidence Integration for Water Column Invertebrates
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 2:
Maintain a stable and healthy water column invertebrate community
Are the COPEC levels in the water column sufficiently high to cause biologically-significant changes or impair the function of the water column invertebrate community in the on-Site ponds?

Measurement Endpoints
2.A: Compare dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks

Weight-of-Evidence Integration

Pond 2 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**2.A**				
Undeterminate					
No Harm					

Pond 3 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**2.A**				
Undeterminate					
No Harm					

Pond 4 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm	**2.A**				

Pond 5 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**2.A**				
Yes/Low					
Undeterminate					
No Harm					

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the water column invertebrate community is discussed in Section 7 of the BERA

Attachment 7.40
Hazard Quotients for Surface Water COPECs in Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	34 / 34	18580	5964	750	(a)	87	(1)	**25**	**8.0**	**214**	**69**
Cadmium	33 / 34	5.1	3.3	2	(a)	0.25	(1)	**2.5**	**1.6**	**20**	**13**
Chromium	30 / 35	5.1	4.4	16	(a)	11	(1)	0.3	0.3	0.5	0.4
Cobalt	35 / 35	333.9	98	1500	(c)	24	(4)	0.2	0.1	**14**	**4**
Copper	35 / 35	5530	2532	13	(a)	9.0	(1)	**425**	**195**	**614**	**281**
Iron	32 / 35	39994	9762	NA		1000	(1)	--	--	**40**	**10**
Manganese	35 / 35	1034	562	2300	(c)	120	(6)	0.4	0.2	**8.6**	**4.7**
Nickel	35 / 35	34.9	29.9	470	(a)	52	(1)	0.1	0.1	0.7	0.6
Silver	7 / 35	0.7	2.09	3.2	(a)	0.32	(1)	0.2	0.7	**2.2**	**6.5**
Zinc	34 / 34	588	496	120	(a)	120	(1)	**4.9**	**4.1**	**4.9**	**4.1**

ug/L - micorgrams per liter
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
NA - Not available
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.41
Hazard Quotients for Surface Water COPECs in the Upstream Reference Section of the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	9 / 10	35.0	15.2	750	(a)	87	(1)	0.05	0.02	0.4	0.2
Cadmium	0 / 10	10.5	5.0	2	(a)	0.25	(1)	**5.3**	**2.5**	**42**	**20**
Chromium	4 / 10	0.7	10.6	16	(a)	11	(1)	0.05	0.7	0.07	0.96
Cobalt	4 / 10	0.14	2.0	1500	(c)	24	(4)	0.0001	0.001	0.01	0.1
Copper	8 / 10	29.5	7.7	13	(a)	9.0	(1)	**2.3**	0.6	**3.3**	0.9
Iron	8 / 10	30.0	17.9	NA		1000	(1)	--	--	0.03	0.02
Manganese	10 / 10	136.0	23.6	2300	(c)	120	(6)	0.1	0.01	**1.1**	0.20
Nickel	8 / 10	1.9	5.5	470	(a)	52	(1)	0.004	0.01	0.04	0.1
Silver	2 / 10	0.25	5.9	3.2	(a)	0.32	(1)	0.1	**1.9**	0.8	**18.53**
Zinc	10 / 10	77.6	50.0	120	(a)	120	(1)	0.6	0.4	0.6	0.4

ug/L - micorgrams per liter
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.42
Incremental Risk for Surface Water in the Main Stem of Ely Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	**25**	**8**	0.05	0.02	**25**	**8**	**214**	**69**	0.40	0.17	**213**	**68**
Cadmium	**3**	**2**	**5.3**	**3**	<1	<1	**20**	**13**	**42**	**20**	<1	<1
Chromium	0.3	0.3	0.05	0.7	<1	<1	0.5	0.4	0.07	1.0	<1	<1
Cobalt	0	0.1	0.0001	0.001	<1	<1	**14**	**4**	0.01	0.09	**14**	**4.0**
Copper	**425**	**195**	**2.3**	0.6	**423**	**194**	**614**	**281**	**3.3**	0.9	**611**	**281**
Iron	--	--	--	--	--	--	**40**	**10**	0.03	0.02	**40**	**10**
Manganese	0.4	0.2	0.1	0.01	<1	<1	**8.6**	**4.7**	**1.1**	0.20	**7.5**	**4.5**
Nickel	0.1	0.1	0.004	0.01	<1	<1	0.7	0.6	0.04	0.11	<1	<1
Silver	0.2	0.7	0.1	**2**	<1	<1	**2.2**	**6.5**	0.8	**19**	**1.4**	<1
Zinc	**4.9**	**4.1**	0.6	0.4	**4.3**	**3.7**	**4.9**	**4.1**	0.6	0.4	**4.3**	**3.7**

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.43
Hazard Quotients for Surface Water COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	36 / 36	97.3	87.8	750	(a)	87	(1)	0.1	0.1	**1.1**	**1.0**
Barium	36 / 36	87.2	37.9	110	(c)	220	(4)	0.8	0.3	0.4	0.2
Cadmium	24 / 44	0.23	0.58	2	(a)	0.25	(1)	0.1	0.3	0.9	**2.3**
Copper	9 / 44	112	74	13	(a)	9.0	(1)	**8.6**	**5.7**	**12.5**	**8.3**
Zinc	35 / 37	69.9	41	120	(a)	120	(1)	0.6	0.3	0.6	0.3

ug/L - micrograms per liter
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.44
Hazard Quotients for Surface Water COPECs in Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	11 / 13	75.5	21.7	750	(a)	87	(1)	0.1	0.03	0.9	0.2
Barium	13 / 13	159	55.5	110	(c)	220	(4)	**1.4**	0.5	0.7	0.3
Cadmium	0 / 16	7.8	2.4	2	(a)	0.25	(1)	**3.9**	**1.2**	**31**	**9.4**
Copper	7 / 16	1.2	4.7	13	(a)	9.0	(1)	0.1	0.4	0.1	0.5
Zinc	12 / 13	86.7	32.4	120	(a)	120	(1)	0.7	0.3	0.7	0.3

ug/L - micrograms per liter
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
COPECs - Chemicals of Potential Ecological Concern
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.45
Incremental Risk for Surface Water in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	0.1	0.1	0.1	0.03	<1	<1	**1.1**	**1.0**	0.9	0.2	<1	<1
Barium	0.8	0.3	**1.4**	0.5	<1	<1	0.4	0.2	0.7	0.3	<1	<1
Cadmium	0.1	0.3	**3.9**	**1.2**	<1	<1	0.9	**2.3**	**31.2**	**9.4**	<1	<1
Copper	**8.6**	**5.7**	0.1	0.4	**8.5**	**5.4**	**12.5**	**8.3**	0.1	0.5	**12**	**7.8**
Zinc	0.6	0.3	0.7	0.3	<1	<1	0.6	0.3	0.7	0.3	<1	<1

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference location.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF- Reference

Attachment 7.46
Hazard Quotients for Surface Water COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ		Chronic HQ	
								RME	CTE	RME	CTE
Metals, Dissolved (ug/L)											
Aluminum	26 / 29	47.5	39.1	750	(a)	87	(1)	0.1	0.1	0.5	0.4
Barium	29 / 29	282	68.7	110	(c)	220	(4)	**2.6**	0.6	**1.3**	0.3
Copper	28 / 29	28.6	14.1	13	(a)	9.0	(1)	**2.2**	**1.1**	**3.2**	**1.6**
Lead	8 / 29	3.55	20.4	65	(a)	2.5	(1)	0.1	0.3	**1.4**	**8.2**
Manganese	29 / 29	40.9	18.1	2300	(c)	120	(6)	0.02	0.01	0.3	0.2
Silver	4 / 29	0.43	3.1	3.2	(a)	0.32	(1)	0.1	1.0	**1.4**	**9.7**
Zinc	29 / 29	4731	809	120	(a)	120	(1)	**39**	**6.7**	**39**	**6.7**

ug/L - micorgrams per liter
EBOR - East Branch of the Opompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.47
Hazard Quotients for Surface Water Column COPECs in the Upstream Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	Acute Surface Water Benchmark	Source	Chronic Surface Water Benchmark	Source	Acute HQ RME	Acute HQ CTE	Chronic HQ RME	Chronic HQ CTE
Metals, Dissolved (ug/L)											
Aluminum	10 / 10	47.1	15.3	750	(a)	87	(1)	0.1	0.02	0.5	0.2
Barium	10 / 10	180	62.6	110	(c)	220	(4)	**1.6**	0.6	0.8	0.3
Copper	2 / 10	0.96	4.2	13	(a)	9.0	(1)	0.1	0.3	0.1	0.5
Lead	1 / 10	0.09	24.3	65	(a)	2.5	(1)	0.001	0.4	0.04	**9.7**
Manganese	10 / 10	15.0	10.3	2300	(c)	120	(6)	0.007	0.004	0.1	0.09
Silver	4 / 10	0.08	0.54	3.2	(a)	0.32	(1)	0.03	0.2	0.3	**1.7**
Zinc	10 / 10	54.6	23	120	(a)	120	(1)	0.5	0.2	0.5	0.2

ug/L - micrograms per liter
EBOR - East Branch of the Opompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
1. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
2. State of Vermont. 2006. Vermont Water Quality Standards.
3. U.S. EPA. 1996. ECO Update: Ecotox Thresholds. EPA 540/F-95/038. January, 1996.
4. USEPA.2003. Region V Ecological Screening Levels. www.epa.gov/RCRIS-region-5/ca/ESL.pdf
5. Buchman, M.F. 1999. Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Coastal Protection Division, NOAA.
6. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

a. U.S. EPA. 2006. National Recommended Water Quality Criteria: 2006.
b. State of Vermont. 2006. Vermont Water Quality Standards.
c. Suter, G.W. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory.

Attachment 7.48
Incremental Risk for Surface Water in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	Acute Scenario						Chronic Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	0.1	0.1	0.1	0.02	<1	<1	0.5	0.4	0.5	0.2	<1	<1
Barium	**2.6**	0.6	**1.6**	0.6	<1	<1	**1.3**	0.3	0.8	0.3	<1	<1
Copper	**2.2**	**1.1**	0.1	0.3	**2.1**	<1	**3.2**	**1.6**	0.1	0.5	**3.1**	**1.1**
Lead	0.1	0.3	0.001	0.4	<1	<1	**1.4**	**8.2**	0.04	**9.7**	**1.4**	<1
Manganese	0.02	0.01	0.01	0.004	<1	<1	0.3	0.2	0.1	0.09	<1	<1
Silver	0.1	1.0	0.0	0.2	<1	<1	**1.4**	**9.7**	0.3	**1.7**	**1.1**	**8.0**
Zinc	**39**	**6.7**	0.5	0.2	**39**	**6.5**	**39**	**6.7**	0.5	0.2	**39**	**6.5**

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
REF - Reference

Attachment 7.49
Hazard Quotients for Brook Trout COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminium	1 / 1	12.4	12.4	4.2	13.5	**3.0**	**3.0**	0.9	0.9
Barium	1 / 1	0.30	0.30	NA	NA	--	--	--	--
Beryllium	0 / 1	0.005	0.005	NA	NA	--	--	--	--
Cadmium	1 / 1	0.02	0.02	0.10	0.29	0.2	0.2	0.1	0.1
Chromium	1 / 1	0.30	0.30	0.58	NA	0.5	0.5	--	--
Cobalt	1 / 1	0.10	0.10	NA	NA	--	--	--	--
Copper	1 / 1	7.9	7.9	NA	2.4	--	--	**3.3**	**3.3**
Iron	1 / 1	46.9	46.9	NA	NA	--	--	--	--
Lead	1 / 1	0.02	0.02	3.8	4.0	0.01	0.01	0.01	0.01
Manganese	1 / 1	2.9	2.9	NA	NA	--	--	--	--
Mercury	1 / 1	0.003	0.003	NA	0.73	--	--	0.004	0.004
Molybdenum	0 / 1	0.15	0.15	NA	NA	--	--	--	--
Selenium	1 / 1	0.30	0.30	0.37	0.76	0.8	0.8	0.4	0.4
Thallium	0 / 1	0.015	0.015	NA	NA	--	--	--	--
Vanadium	0 / 1	0.10	0.10	0.02	0.41	**5.0**	**5.0**	0.2	0.2
Zinc	1 / 1	18.8	18.8	16.4	NA	**1.1**	**1.1**	--	--

mg/kg, wwt - milligrams per kilogram, wet weight
CBR - Critical Body Residue (mg/kg, wwt)
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
NA - Not available

Attachment 7.50
Hazard Quotients for Brook Trout in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminium	5 / 5	4.8	6.9	4.2	13.5	**1.1**	**1.6**	0.4	0.5
Barium	5 / 5	0.366	0.48	NA	NA	--	--	--	--
Beryllium	0 / 5	0.005	0.01	NA	NA	--	--	--	--
Cadmium	5 / 5	0.046	0.08	0.10	0.29	0.5	0.8	0.2	0.3
Chromium	5 / 5	0.44	0.60	0.58	NA	0.8	**1.0**	--	--
Cobalt	5 / 5	0.046	0.06	NA	NA	--	--	--	--
Copper	5 / 5	1.64	1.9	NA	2.4	--	--	0.7	0.8
Iron	5 / 5	32.9	36.0	NA	NA	--	--	--	--
Lead	5 / 5	0.03	0.06	3.80	4	0.01	0.02	0.01	0.02
Manganese	5 / 5	3.1	3.7	NA	NA	--	--	--	--
Mercury	5 / 5	0.0082	0.01	NA	0.73	--	--	0.01	0.01
Molybdenum	0 / 5	0.15	0.15	NA	NA	--	--	--	--
Selenium	5 / 5	0.50	0.60	0.37	0.76	**1.4**	**1.6**	0.7	0.8
Thallium	0 / 5	0.02	0.02	NA	NA	--	--	--	--
Vanadium	2 / 5	0.12	0.20	0.02	0.41	**6**	**10.0**	0.3	0.5
Zinc	5 / 5	21.5	23.2	16.4	NA	**1.3**	**1.4**	--	--

mg/kg, wwt - milligrams per kilogram, wet weight
CBR - Critical Body Residue (mg/kg, wwt)
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
NA - Not available

Attachment 7.51
Incremental Risk for Brook Trout in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminium	**3.0**	**3.0**	**1.1**	**1.6**	**1.8**	**1.3**	0.9	0.9	0.4	0.5	<1	<1
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.2	0.2	0.5	0.8	<1	<1	0.1	0.1	0.2	0.3	<1	<1
Chromium	0.5	0.5	0.8	**1.0**	<1	<1	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	**3.3**	**3.3**	0.7	0.8	**2.6**	**2.5**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.01	0.01	0.01	0.02	<1	<1	0.01	0.01	0.01	0.02	<1	<1
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	0.004	0.004	0.01	0.01	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.8	0.8	**1.4**	**1.6**	<1	<1	0.4	0.4	0.7	0.8	<1	<1
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**5.0**	**5.0**	**6**	**10.0**	<1	<1	0.2	0.2	0.3	0.5	<1	<1
Zinc	**1.1**	**1.1**	**1.3**	**1.4**	<1	<1	--	--	--	--	--	--

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

-- - A hazard quotient could not be calculated because no Critical Body Residue value was available.

REF - Reference

Attachment 7.52
Hazard Quotients for Blacknose Dace COPECs in School House Brook
Baseline Ecological Risk Assessment
Ely Cooper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminium	8 / 8	11.5	4.8	4.2	13.5	**2.7**	**1.1**	0.9	0.4
Antimony	4 / 8	0.40	0.13	5	9	0.1	0.03	0.04	0.01
Barium	8 / 8	2.3	2.0	NA	NA	--	--	--	--
Beryllium	0 / 8	0.005	0.01	NA	NA	--	--	--	--
Cadmium	8 / 8	0.07	0.04	0.1	0.29	0.7	0.4	0.2	0.1
Chromium	8 / 8	0.50	0.39	0.58	NA	0.9	0.7	--	--
Cobalt	8 / 8	0.11	0.05	NA	NA	--	--	--	--
Copper	8 / 8	5.9	4.15	NA	2.4	--	--	**2.5**	**1.7**
Iron	8 / 8	44.7	33.2	NA	NA	--	--	--	--
Lead	8 / 8	1.2	0.16	3.8	4.0	0.3	0.04	0.3	0.04
Manganese	8 / 8	4.2	3.7	NA	NA	--	--	--	--
Mercury	8 / 8	0.021	0.014	NA	0.73	--	--	0.03	0.02
Molybdenum	0 / 8	0.15	0.15	NA	NA	--	--	--	--
Nickel	8 / 8	0.2	0.19	0.82	NA	0.2	0.2	--	--
Selenium	8 / 8	0.5	0.43	0.37	0.76	**1.4**	**1.1**	0.7	0.6
Thallium	0 / 8	0.02	0.02	NA	NA	--	--	--	--
Vanadium	2 / 8	0.10	0.10	0.02	0.41	**5.0**	**5.0**	0.2	0.2
Zinc	8 / 8	40.9	36.1	16.4	NA	**2.5**	**2.2**	--	--

mg/kg, wwt - milligrams per kilogram, wet weight
CBR - Critical Body Residue (mg/kg, wwt)
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Attachment 7.53
Hazard Quotients for Blacknose Dace COPECs in the Upstream Reference Section of School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminium	2 / 2	26.5	20.7	4.2	13.5	**6.3**	**4.9**	**2.0**	**1.5**
Antimony	0 / 2	0.05	0.05	5.0	9.0	0.01	0.01	0.01	0.01
Barium	2 / 2	1.1	1.1	NA	NA	--	--	--	--
Beryllium	0 / 2	0.005	0.005	NA	NA	--	--	--	--
Cadmium	2 / 2	0.06	0.06	0.1	0.29	0.6	0.6	0.2	0.2
Chromium	2 / 2	0.50	0.50	0.58	NA	0.9	0.9	--	--
Cobalt	2 / 2	0.04	0.035	NA	NA	--	--	--	--
Copper	2 / 2	1.0	0.95	NA	2.4	--	--	0.4	0.4
Iron	2 / 2	60.5	52.80	NA	NA	--	--	--	--
Lead	2 / 2	0.05	0.1	3.8	4.0	0.01	0.01	0.01	0.01
Manganese	2 / 2	6.1	5.71	NA	NA	--	--	--	--
Mercury	2 / 2	0.02	0.0	NA	0.73	--	--	0.02	0.02
Molybdenum	0 / 2	0.15	0.15	NA	NA	--	--	--	--
Nickel	2 / 2	0.20	0.20	0.82	NA	0.2	0.2	--	--
Selenium	2 / 2	0.70	0.70	0.37	0.76	**1.9**	**1.9**	0.9	0.9
Thallium	0 / 2	0.02	0.02	NA	NA	--	--	--	--
Vanadium	2 / 2	0.20	0.2	0.02	0.41	**10**	**10**	0.5	0.5
Zinc	2 / 2	33.9	31.8	16.4	NA	**2.1**	**1.9**	--	--

mg/kg, wwt - milligrams per kilogram, wet weight
CBR - Critical Body Residue (mg/kg, wwt)
COPECs - Chemicals of Potential Ecological Concern
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
NA - Not available

Attachment 7.54
Incremental Risk for Blacknose Dace in School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPECs	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminium	**2.7**	**1.1**	**6.3**	**4.9**	<1	<1	0.9	0.4	**2.0**	**1.5**	<1	<1
Antimony	0.1	0.03	0.01	0.01	<1	<1	0.04	0.01	0.01	0.01	<1	<1
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.7	0.4	0.6	0.6	<1	<1	0.2	0.1	0.2	0.2	<1	<1
Chromium	0.9	0.7	0.9	0.9	<1	<1	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	**2.5**	**1.7**	0.4	0.4	**2.0**	**1.3**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.3	0.04	0.01	0.01	<1	<1	0.3	0.04	0.01	0.01	<1	<1
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	0.03	0.02	0.02	0.02	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.2	0.2	0.2	0.2	<1	<1	--	--	--	--	--	--
Selenium	**1.4**	**1.1**	**1.9**	**1.9**	<1	<1	0.7	0.6	0.9	0.9	<1	<1
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**5.0**	**5.0**	**10**	**10**	<1	<1	0.2	0.2	0.5	0.5	<1	<1
Zinc	**2.5**	**2.2**	**2.1**	**1.9**	<1	<1	--	--	--	--	--	--

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

-- - A hazard quotietn could not be calculated because no Critical Body Residue value was available.

Attachment 7.55
Hazard Quotients for Brook Trout COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminum	2 / 2	3.4	2.3	4.2	13.5	0.8	0.5	0.3	0.2
Barium	2 / 2	0.51	0.48	NA	NA	--	--	--	--
Beryllium	0 / 2	0.005	0.005	NA	NA	--	--	--	--
Cadmium	2 / 2	0.03	0.02	0.10	0.29	0.3	0.2	0.1	0.1
Chromium	1 / 2	0.30	0.23	0.58	NA	0.5	0.4	--	--
Cobalt	2 / 2	0.06	0.04	NA	NA	--	--	--	--
Copper	2 / 2	1.3	1.1	NA	2.4	--	--	0.5	0.4
Iron	2 / 2	24.6	22.8	NA	NA	--	--	--	--
Lead	1 / 2	0.01	0.008	3.8	4.0	0.003	0.002	0.003	0.002
Manganese	2 / 2	3.1	2.6	NA	NA	--	--	--	--
Mercury	2 / 2	0.006	0.006	NA	0.73	--	--	0.01	0.01
Molybdenum	0 / 2	0.15	0.15	NA	NA	--	--	--	--
Nickel	1 / 2	0.10	0.08	0.82	NA	0.1	0.1	--	--
Selenium	2 / 2	0.30	0.30	0.37	0.76	0.8	0.8	0.4	0.4
Thallium	0 / 2	0.02	0.02	NA	NA	--	--	--	--
Vanadium	0 / 2	0.10	0.10	0.02	0.41	**5.0**	**5.0**	0.2	0.2
Zinc	2 / 2	18.2	17.4	16.4	NA	**1.1**	**1.1**	--	--

mg/kg wwt - milligrams per kilogram, wet weight
EBOR - East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
CBR - Critical Body Residue
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Attachment 7.56
Incremental Risk for Brook Trout in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPECs	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	0.8	0.5	NA	NA	<1	<1	0.3	0.2	NA	NA	<1	<1
Barium	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Beryllium	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Cadmium	0.3	0.2	NA	NA	<1	<1	0.1	0.1	NA	NA	<1	<1
Chromium	0.5	0.4	NA	NA	<1	<1	--	--	NA	NA	--	--
Cobalt	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Copper	--	--	NA	NA	--	--	0.5	0.4	NA	NA	<1	<1
Iron	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Lead	0.003	0.002	NA	NA	<1	<1	0.003	0.002	NA	NA	<1	<1
Manganese	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Mercury	--	--	NA	NA	--	--	0.01	0.01	NA	NA	<1	<1
Molybdenum	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Nickel	0.1	0.1	NA	NA	<1	<1	--	--	NA	NA	--	--
Selenium	0.8	0.8	NA	NA	<1	<1	0.4	0.4	NA	NA	<1	<1
Thallium	--	--	NA	NA	--	--	--	--	NA	NA	--	--
Vanadium	**5.0**	**5.0**	NA	NA	**5.0**	**5.0**	0.2	0.2	NA	NA	<1	<1
Zinc	**1.1**	**1.1**	NA	NA	**1.1**	**1.1**	--	--	NA	NA	--	--

Note: No Brook Trout were collected from the reference portion of the Ompompanoosuc River.
EBOR - East Branch of the Opompanoosuc River
COPECs - Chemicals of Potential Ecological Concern
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
-- - A hazard quotient could not be calculated because no Critical Body Residue value was available.
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
NA - Not available

Hazard Quotients for Blacknose Dace COPECs in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminum	6 / 6	16.8	8.72	4.2	13.5	**4.0**	**2.1**	**1.2**	0.6
Barium	6 / 6	2.4	2.1	NA	NA	--	--	--	--
Beryllium	0 / 6	0.005	0.01	NA	NA	--	--	--	--
Cadmium	6 / 6	0.07	0.05	0.10	0.29	0.7	0.5	0.2	0.2
Chromium	6 / 6	0.30	0.28	0.58	NA	0.5	0.5	--	--
Cobalt	6 / 6	0.09	0.08	NA	NA	--	--	--	--
Copper	6 / 6	3.5	2.4	NA	2.4	--	--	**1.5**	**1.0**
Iron	6 / 6	50.8	35.5	NA	NA	--	--	--	--
Lead	6 / 6	0.04	0.03	3.8	4.0	0.01	0.01	0.01	0.01
Manganese	6 / 6	6.4	5.3	NA	NA	--	--	--	--
Mercury	6 / 6	0.02	0.02	NA	0.73	--	--	0.03	0.02
Molybdenum	0 / 6	0.15	0.15	NA	NA	--	--	--	--
Nickel	6 / 6	0.20	0.17	0.82	NA	0.2	0.2	--	--
Selenium	6 / 6	0.50	0.38	0.37	0.76	**1.4**	**1.0**	0.7	0.5
Thallium	0 / 6	0.02	0.02	NA	NA	--	--	--	--
Vanadium	0 / 6	0.10	0.10	0.02	0.41	**5.0**	**5.0**	0.2	0.2
Zinc	6 / 6	41.6	39.0	16.4	NA	**2.5**	**2.4**	--	--

mg/kg, wwt = Milligrams per kilogram, wet weight
EBOR - East Branch of the Ompompanoosuc River
COPECs - Chemicals of Potential Ecological Conern
CBR - Critical Body Residue
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient

Attachment 7.58
Hazard Quotients for Blacknose Dace COPECs in the Reference Section of the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	Frequency of Detection	Reasonable Maximum	Central Tendency	No Effect CBR	Effect CBR	No Effect HQ		Effect HQ	
						RME	CTE	RME	CTE
Metals (mg/kg, wwt)									
Aluminium	3 / 3	8.9	6.4	4.2	13.5	**2.1**	**1.5**	0.7	0.5
Barium	3 / 3	2.3	2.2	NA	NA	--	--	--	--
Beryllium	0 / 3	0.005	0.01	NA	NA	--	--	--	--
Cadmium	3 / 3	0.04	0.03	0.1	0.29	0.4	0.3	0.1	0.1
Chromium	3 / 3	0.40	0.33	0.58	NA	0.7	0.6	--	--
Cobalt	3 / 3	0.02	0.02	NA	NA	--	--	--	--
Copper	3 / 3	2.1	1.2	NA	2.4	--	--	0.9	0.5
Iron	3 / 3	33.5	30.9	NA	NA	--	--	--	--
Lead	3 / 3	0.03	0.03	3.8	4	0.01	0.01	0.01	0.01
Manganese	3 / 3	5.5	5.3	NA	NA	--	--	--	--
Mercury	3 / 3	0.03	0.02	NA	0.73	--	--	0.04	0.03
Molybdenum	0 / 3	0.15	0.15	NA	NA	--	--	--	--
Nickel	3 / 3	0.20	0.20	0.82	NA	0.2	0.2	--	--
Selenium	3 / 3	0.40	0.40	0.37	0.76	**1.1**	**1.1**	0.5	0.5
Thallium	0 / 3	0.02	0.02	NA	NA	--	--	--	--
Vanadium	0 / 3	0.10	0.10	0.02	0.41	**5.0**	**5.0**	0.2	0.2
Zinc	3 / 3	42.5	39.0	16.4	NA	**2.6**	**2.4**	--	--

mg/kg, wwt = Milligrams per kilogram, wet weight
COPECs - Chemicals of Potential Ecological Conern
EBOR - East Branch of the Ompompanoosuc River
CBR - Critical Body Residue
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

Attachment 7.59
Incremental Risk for Blacknose Dace in the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	**4.0**	**2.1**	**2.1**	**1.5**	**1.9**	<1	**1.2**	0.6	0.7	0.5	<1	<1
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.7	0.5	0.4	0.3	<1	<1	0.2	0.2	0.1	0.1	<1	<1
Chromium	0.5	0.5	0.7	0.6	<1	<1	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	**1.5**	**1.0**	0.9	0.5	<1	<1
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.01	0.01	0.01	0.01	<1	<1	0.01	0.01	0.01	0.01	<1	<1
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	0.03	0.02	0.04	0.03	<1	<1
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.2	0.2	0.2	0.2	<1	<1	--	--	--	--	--	--
Selenium	**1.4**	**1.0**	**1.1**	**1.1**	<1	<1	0.7	0.5	0.5	0.5	<1	<1
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**5.0**	**5.0**	**5.0**	**5.0**	<1	<1	0.2	0.2	0.2	0.2	<1	<1
Zinc	**2.5**	**2.4**	**2.6**	**2.4**	<1	<1	--	--	--	--	--	--

COPECs - Chemicals of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

-- - A hazard quotient could not be calculated because no Critical Body Residue value was available.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

Attachment 7.60: Weight-of-Evidence Integration for Fish
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 3:
Maintain a stable and healthy fish community
Are the COPEC levels in surface water sufficiently high to cause biologically-significant changes or impair the function of the fish community in the three streams affected by Ely Mine?

Measurement Endpoints
3.A: Compare dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks
3.B: Survival and growth in juvenile fathead minnows (*P. promelas)*
3.C: Compare COPEC levels measured in whole fish to no effect and effect CBRs
3.D: Evaluate the structure and function of the fish community in the field

Weight-of-Evidence Integration

The main stem of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**3.A**		**3.B**		
Yes/Low					
Undeterminate					
No Harm					

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**3.A**		**3.B**		**3.D**
Yes/Low			**3.C**		
Undeterminate					
No Harm					

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**3.A**				
Yes/Low					
Undeterminate					
No Harm			**3.C**		**3.D**

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the fish community is discussed in Section 7 of the BERA

Attachment 7.61: Weight-of-Evidence Integration for Amphibians
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 4:
Maintain stable and healthy amphibian populations
Are the COPEC levels in the water column sufficiently high to cause biologically-significant changes or impair the function of the amphibian populations at the on-Site ponds?

Measurement Endpoints
4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks
4.B: Survival and growth in juvenile fathead minnows (*P. promelas*)
4.C: Evaluate hatching and survival of wood frog eggs and tadpoles exposed to the ponds in the field

Weight-of-Evidence Integration

Pond 2 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**4.A**				
Undeterminate					
No Harm					

Pond 3 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low	**4.A**				
Undeterminate					
No Harm					

Pond 4 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High			**4.B**		**4.C**
Yes/Low					
Undeterminate					
No Harm	**4.A**				

Pond 5 on the east branch of Ely Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High	**4.A**		**4.B**		**4.C**
Yes/Low					
Undeterminate					
No Harm					

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the amphibian populations is discussed in Section 7 of the BERA

Attachment 7.62
Hazard Quotients for Tree Swallow COPECs at School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	2.12E+03	--	--	--	--	1.24E+03	--	--	--	--
Antimony	8.61E-01	--	--	--	--	1.27E+00	--	--	--	--
Arsenic	6.41E-01	5.5	22	0.1	0.03	4.67E-01	5.5	22	0.1	0.02
Barium	1.82E+02	208	416	0.9	0.4	1.06E+02	208	416	0.5	0.3
Beryllium	3.77E-01	--	--	--	--	1.32E-01	--	--	--	--
Cadmium^	-1.40E-02	1.9	21.1	-0.01	-0.001	3.65E-02	1.9	21.1	0.02	0.002
Chromium	2.46E+01	37.7	75.4	0.7	0.3	2.10E+01	37.7	75.4	0.6	0.3
Cobalt	1.51E+02	7.61	38.1	**20**	**4.0**	4.94E+01	7.61	38.1	**6.5**	**1.3**
Copper	6.74E+02	33	62	**20**	**11**	4.08E+02	33	62	**12.4**	**6.6**
Iron	7.62E+03	--	--	--	--	1.85E+03	--	--	--	--
Lead	1.60E+00	7.4	37	0.2	0.04	4.05E-01	7.4	37	0.1	0.01
Manganese	5.95E+02	977	4885	0.6	0.1	4.02E+02	977	4885	0.4	0.1
Mercury	4.67E-02	0.45	0.91	0.1	0.1	5.57E-02	0.45	0.91	0.1	0.1
Molybdenum	4.70E+00	7.1	35.3	0.7	0.1	2.52E+00	7.1	35.3	0.4	0.1
Nickel	5.24E+01	80	107	0.7	0.5	3.30E+01	80	107	0.4	0.3
Selenium	3.13E+00	0.4	0.8	**7.8**	**3.9**	2.23E+00	0.4	0.8	**5.6**	**2.8**
Silver	1.59E-01	14.5	43.6	0.01	0.004	2.17E-01	14.5	43.6	0.01	0.00
Strontium	3.81E+02	--	--	--	--	3.50E+02	--	--	--	--
Vanadium	6.29E+01	11.4	56.9	**5.5**	**1.1**	3.16E+01	11.38	56.9	**2.8**	0.6
Zinc	9.73E+01	14.5	131	**6.7**	0.7	8.67E+01	14.5	131	**6.0**	0.7

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value and therefore a negative EDD.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
TRV - Toxicity Reference Value
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.48

Attachment 7.63
Hazard Quotients for Tree Swallow COPECs in the
Upstream Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	2.12E+03	--	--	--	--	1.29E+03	--	--	--	--
Antimony	5.40E-02	--	--	--	--	1.16E+00	--	--	--	--
Arsenic	6.86E-01	5.5	22	0.1	0.03	4.97E-01	5.5	22	0.1	0.0
Barium	2.54E+02	208	416	**1.2**	0.6	1.11E+02	208	416	0.5	0.3
Beryllium	4.69E-01	--	--	--	--	1.41E-01	--	--	--	--
Cadmium	8.33E-01	1.9	21.1	0.4	0.04	2.91E-02	1.9	21.1	0.0	0.00
Chromium	5.50E+01	37.7	75.4	**1.5**	0.7	2.45E+01	37.7	75.4	0.6	0.3
Cobalt	1.20E+01	7.61	38.1	**1.6**	0.3	9.11E+00	7.61	38.1	**1.2**	0.2
Copper	1.84E+01	33	62	0.6	0.3	1.31E+01	33	62	0.4	0.2
Iron	3.34E+03	--	--	--	--	1.29E+03	--	--	--	--
Lead	5.72E-01	7.4	37	0.1	0.02	2.75E-01	7.4	37	0.0	0.0
Manganese	5.45E+02	977	4885	0.6	0.1	4.02E+02	977	4885	0.4	0.1
Mercury	2.72E-02	0.45	0.91	0.1	0.03	5.97E-02	0.45	0.91	0.1	0.1
Molybdenum	5.80E-01	7.1	35.3	0.1	0.02	1.14E+00	7.1	35.3	0.2	0.03
Nickel	5.04E+01	80	107	0.6	0.5	3.40E+01	80	107	0.4	0.3
Selenium	3.71E-02	0.4	0.8	0.1	0.05	2.01E-01	0.4	0.8	0.5	0.3
Silver	1.17E-01	14.5	43.6	0.01	0.003	3.14E-01	14.5	43.6	0.0	0.01
Strontium	4.63E+02	--	--	--	--	4.13E+02	--	--	--	--
Thallium	2.56E+01	--	--	--	--	3.54E+00	--	--	--	--
Vanadium	4.91E+01	11.4	56.9	**4.3**	0.9	2.64E+01	11.38	56.9	**2.3**	0.5
Zinc	6.07E+01	14.5	131	**4.2**	0.5	4.36E+01	14.5	131	**3.0**	0.3

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
TRV - Toxicity Reference Value
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.49

Attachment 7.64
Incremental Risk for Tree Swallows at School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.1	0.1	0.1	0.1	<1	<1	0.0	0.02	0.03	0.0	<1	<1
Barium	0.9	0.5	**1.2**	0.5	<1	<1	0.4	0.3	0.6	0.3	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium^	0.0	0.0	0.4	0.0	<1	<1	-0.001	0.00	0.04	0.00	<1	<1
Chromium	0.7	0.6	**1.5**	0.6	<1	<1	0.3	0.3	0.7	0.3	<1	<1
Cobalt	**20**	**6.5**	**1.6**	**1.2**	**18**	**5.3**	**4.0**	**1.3**	0.3	0.2	**3.6**	**1.1**
Copper	**20**	**12.4**	0.6	0.4	**20**	**12**	**11**	**6.6**	0.3	0.2	**11**	**6.4**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.2	0.1	0.1	0.0	<1	<1	0.04	0.01	0.02	0.0	<1	<1
Manganese	0.6	0.4	0.6	0.4	<1	<1	0.1	0.1	0.11	0.1	<1	<1
Mercury	0.1	0.1	0	0	<1	<1	0.1	0.1	0	0	<1	<1
Molybdenum	0.7	0.4	0.1	0.2	<1	<1	0.1	0.1	0.02	0.03	<1	<1
Nickel	0.7	0.4	0.6	0.4	<1	<1	0.5	0.3	0.5	0.3	<1	<1
Selenium	**7.8**	**5.6**	0.1	0.5	**7.7**	**5.1**	**3.9**	**2.8**	0.05	0.3	**3.9**	**2.5**
Silver	0.0	0.01	0.01	0.0	<1	<1	0.004	0.00	0.003	0.01	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**5.5**	**2.8**	**4.3**	**2.3**	**1.2**	<1	**1.1**	0.6	0.9	0.5	<1	<1
Zinc	**6.7**	**6.0**	**4.2**	**3.0**	**2.5**	**3.0**	0.7	0.7	0.5	0.3	<1	<1

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.65
Hazard Quotients for Tree Swallow COPECs at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	2.47E+03	--	--	--	--	1.38E+03	--	--	--	--
Antimony	6.48E-01	--	--	--	--	1.33E+00	--	--	--	--
Arsenic	1.14E+00	5.5	22	0.2	0.1	6.01E-01	5.5	22	0.1	0.0
Barium	1.54E+02	208	416	0.7	0.4	7.93E+01	208	416	0.4	0.2
Beryllium	4.22E-01	--	--	--	--	9.28E-02	--	--	--	--
Cadmium	-9.93E-02	1.9	21.1	-0.1	-0.005	5.56E-02	1.9	21.1	0.0	0.0
Chromium	3.33E+01	37.7	75.4	0.9	0.4	2.00E+01	37.7	75.4	0.5	0.3
Cobalt	1.97E+02	7.61	38.1	**26**	**5.2**	2.56E+01	7.61	38.1	**3.4**	0.7
Copper	1.69E+02	33	62	**5.1**	**2.7**	1.00E+02	33	62	**3.0**	**1.6**
Iron	2.95E+03	--	--	--	--	1.39E+03	--	--	--	--
Lead	5.62E-01	7.4	37	0.1	0.02	3.07E-01	7.4	37	0.0	0.0
Manganese	4.32E+02	977	4,885	0.4	0.1	3.22E+02	977	4,885	0.3	0.1
Mercury	4.67E-02	0.45	0.91	0.1	0.1	6.78E-02	0.45	0.91	0.2	0.1
Molybdenum	2.28E+00	7.1	35.3	0.3	0.1	1.91E+00	7.1	35.3	0.3	0.05
Nickel	5.04E+01	80	107	0.6	0.5	3.23E+01	80	107	0.4	0.3
Selenium	2.70E-01	0.4	0.8	0.7	0.3	1.09E+00	0.4	0.8	**2.7**	**1.4**
Silver	1.85E-01	14.5	43.6	0.01	0.004	2.35E-01	14.5	43.6	0.0	0.01
Strontium	3.47E+02	--	--	--	--	3.47E+02	--	--	--	--
Thallium	1.76E+01	--	--	--	--	5.80E+00	--	--	--	--
Vanadium	1.13E+02	11.38	56.9	**9.9**	**2.0**	2.22E+01	11.4	56.9	**2.0**	0.4
Zinc	8.89E+01	14.5	131	**6.1**	0.7	6.60E+01	14.5	131	**4.5**	0.5

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
TRV - Toxicity Reference Value
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 Total EDD is calculated in Attachment 5.50

Attachment 7.66
Hazard Quotients for Tree Swallow COPECs at the Upstream Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.16E+03	--	--	--	--	9.88E+02	--	--	--	--
Antimony	6.84E-02	--	--	--	--	1.27E+00	--	--	--	--
Arsenic	7.01E-01	5.5	22	0.1	0.03	1.48E-01	5.5	22	0.0	0.0
Barium	3.20E+02	208	416	**1.5**	0.8	1.36E+02	208	416	0.7	0.3
Beryllium	3.75E-01	--	--	--	--	1.76E-01	--	--	--	--
Cadmium	8.34E-01	1.9	21.1	0.4	0.04	4.16E-03	1.9	21.1	0.0	0.00
Chromium	3.92E+01	37.7	75.4	**1.0**	0.5	2.21E+01	37.7	75.4	0.6	0.3
Cobalt	7.61E+00	7.61	38.1	1.0	0.2	3.63E+00	7.61	38.1	0.5	0.1
Copper	5.50E+00	33	62	0.2	0.1	3.88E+00	33	62	0.1	0.06
Iron	8.32E+02	--	--	--	--	5.68E+02	--	--	--	--
Lead	4.90E-01	7.4	37	0.1	0.01	3.84E-01	7.4	37	0.1	0.0
Manganese	4.32E+02	977	4885	0.4	0.1	2.53E+02	977	4885	0.3	0.1
Mercury	5.83E-02	0.45	0.9	0.1	0.1	4.20E-02	0.45	0.9	0.1	0.05
Molybdenum	3.31E-01	7.1	35.3	0.05	0.01	3.31E-01	7.1	35.3	0.05	0.01
Nickel	3.03E+01	80	107	0.4	0.3	2.12E+01	80	107	0.3	0.2
Selenium	1.02E+01	0.4	0.8	**26**	**13**	1.34E+00	0.4	0.8	**3.3**	**1.7**
Silver	9.07E-02	14.5	43.60	0.01	0.002	2.46E-01	14.5	43.60	0.0	0.01
Strontium	3.56E+02	--	--	--	--	3.56E+02	--	--	--	--
Thallium	2.24E+01	--	--	--	--	1.16E+01	--	--	--	--
Vanadium	7.49E+01	11.38	56.9	**6.6**	**1.3**	4.01E+01	11.4	56.9	**3.5**	0.70
Zinc	4.99E+01	14.5	131	**3.4**	0.4	3.36E+01	14.5	131	**2.3**	0.3

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
EBOR - East Branch of the Ompompanoosuc River
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
TRV - Toxicity Reference Value
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.51

Attachment 7.67
Incremental Risk for the Tree Swallows at the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.2	0.1	0.1	0.0	<1	<1	0.1	0.0	0.03	0.01	<1	<1
Barium	0.7	0.4	**1.5**	0.7	<1	<1	0.4	0.2	0.8	0.3	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	-0.1	0.0	0.4	0.0	<1	<1	-0.005	0.0	0.04	0.00	<1	<1
Chromium	0.9	0.5	**1.0**	0.6	<1	<1	0.4	0.3	0.5	0.3	<1	<1
Cobalt	**26**	**3.4**	1.0	0.5	**25**	**2.9**	**5.2**	0.7	0.2	0.1	**5.0**	<1
Copper	**5.1**	**3.0**	0.2	0.1	**5.0**	**2.9**	**2.7**	**1.6**	0.09	0.06	**2.6**	**1.6**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.1	0.0	0.1	0.1	<1	<1	0.02	0.0	0.01	0.01	<1	<1
Manganese	0.4	0.3	0.4	0.3	<1	<1	0.1	0.1	0.09	0.1	<1	<1
Mercury	0.1	0.2	0.1	0.1	<1	<1	0.1	0.1	0.06	0.05	<1	<1
Molybdenum	0.3	0.3	0.05	0.05	<1	<1	0.1	0.05	0.01	0.01	<1	<1
Nickel	0.6	0.4	0.4	0.3	<1	<1	0.5	0.3	0.3	0.2	<1	<1
Selenium	0.7	**2.7**	**26**	**3.3**	<1	<1	0.3	**1.4**	**13**	**1.7**	<1	<1
Silver	0.01	0.0	0.01	0.0	<1	<1	0.004	0.01	0.002	0.01	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**10**	**2.0**	**6.6**	**3.5**	**3.3**	<1	**2.0**	0.4	**1.3**	0.7	<1	<1
Zinc	**6.1**	**4.5**	**3.4**	**2.3**	**2.7**	**2.2**	0.7	0.5	0.4	0.3	<1	<1

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
-- - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure

Attachment 7.68: Weight-of-Evidence Integration for Insectivorous Birds
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 5:

Maintain stable and healthy insectivorous bird populations

Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of the insectivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?

Measurement Endpoint
5.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water and winged aquatic insects, and compare these values to TRVs.

Weight-of-Evidence Integration

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low		**5.A**			
Undeterminate					
No Harm					

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low		**5.A**			
Undeterminate					
No Harm					

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the insectivorous bird populations is discussed in Section 7 of the BERA

Attachment 7.69
Hazard Quotients for Eastern Small-footed Bat COPECs at School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.03E+03	--	--	--	--	6.04E+02	--	--	--	--
Antimony	4.21E-01	13.3	66.5	0.03	0.01	6.22E-01	13.3	66.5	0.05	0.01
Arsenic	3.13E-01	5.7	11.6	0.1	0.03	2.32E-01	5.7	11.6	0.04	0.02
Barium	8.89E+01	51.8	259	**1.7**	0.3	5.19E+01	51.8	259	**1.0**	0.2
Beryllium	1.84E-01	0.53	2.7	0.3	0.1	6.48E-02	0.53	2.7	0.1	0.02
Cadmium^	-3.67E-03	5.1	7.1	-0.001	-0.001	9.69E-03	5.1	7.1	0.002	0.001
Chromium	1.08E+00	8.8	44.2	0.1	0.02	9.25E-01	8.8	44.2	0.1	0.02
Cobalt	7.37E+01	7.3	36.7	**10**	**2.0**	2.42E+01	7.3	36.7	**3.3**	0.7
Copper	6.21E+02	11.7	15.1	**53**	**41**	3.77E+02	11.7	15.1	**32**	**25**
Iron	3.73E+03	--	--	--	--	9.04E+02	--	--	--	--
Lead	1.82E+00	34	80	0.1	0.02	4.61E-01	34	80	0.01	0.01
Manganese	2.91E+02	88	284	**3.3**	**1.0**	1.96E+02	88	284	**2.2**	0.7
Mercury	5.74E-03	13.2	56	4.35E-04	1.02E-04	6.82E-03	13.2	56	0.001	1.22E-04
Molybdenum	2.30E+00	2.6	13	0.9	0.2	1.23E+00	2.6	13	0.5	0.1
Nickel	2.56E+01	60	80	0.4	0.3	1.61E+01	60	80	0.3	0.2
Selenium	1.53E+00	0.35	1.05	**4.4**	**1.5**	1.09E+00	0.35	1.05	**3.1**	**1.0**
Silver	7.78E-02	44.4	222	0.002	3.50E-04	1.06E-01	44.4	222	0.002	4.79E-04
Strontium	1.87E+02	--	--	--	--	1.71E+02	--	--	--	--
Thallium	6.25E-01	0.2	1	**3.1**	0.6	6.25E-01	0.2	1	**3.1**	0.6
Vanadium	3.08E+01	5.9	8.3	**5.2**	**3.7**	1.54E+01	5.9	8.3	**2.6**	**1.9**
Zinc	4.76E+01	160	320	0.3	0.1	4.24E+01	160	320	0.3	0.1

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value and therefore a negative EDD.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
TRV - Toxicity Reference Value
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.52

Attachment 7.70
Hazard Quotients for Eastern Small-footed Bat COPECs at the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.03E+03	--	--	--	--	6.30E+02	--	--	--	--
Antimony	2.64E-02	13.3	66.5	0.002	3.97E-04	5.66E-01	13.3	66.5	0.04	0.01
Arsenic	3.35E-01	5.7	11.6	0.1	0.03	2.47E-01	5.7	11.6	0.04	0.02
Barium	1.24E+02	51.8	259	**2.4**	0.5	5.42E+01	51.8	259	**1.0**	0.2
Beryllium	2.30E-01	0.53	2.7	0.4	0.1	6.95E-02	0.53	2.7	0.1	0.03
Cadmium	2.20E-01	5.1	7.1	0.04	0.03	7.85E-03	5.1	7.1	0.002	0.001
Chromium	2.42E+00	8.8	44.2	0.3	0.1	1.08E+00	8.8	44.2	0.1	0.02
Cobalt	5.88E+00	7.3	36.7	0.8	0.2	4.45E+00	7.3	36.7	0.6	0.1
Copper	1.70E+01	11.7	15.1	**1.4**	**1.1**	1.21E+01	11.7	15.1	**1.0**	0.8
Iron	1.63E+03	--	--	--	--	6.29E+02	--	--	--	--
Lead	6.51E-01	34	80	0.02	0.01	3.13E-01	34	80	0.01	0.004
Manganese	2.66E+02	88	284	**3.0**	0.9	1.96E+02	88	284	**2.2**	0.7
Mercury	3.35E-03	13.2	56	2.54E-04	5.98E-05	7.31E-03	13.2	56	0.001	1.31E-04
Molybdenum	2.83E-01	2.6	13	0.1	0.02	5.56E-01	2.6	13	0.2	0.04
Nickel	2.46E+01	60	80	0.4	0.3	1.66E+01	60	80	0.3	0.2
Selenium	1.84E-02	0.35	1.05	0.1	0.02	9.83E-02	0.35	1.05	0.3	0.1
Silver	5.75E-02	44.4	222	0.001	2.59E-04	1.54E-01	44.4	222	0.003	0.001
Strontium	2.26E+02	--	--	--	--	2.02E+02	--	--	--	--
Thallium	1.25E+01	0.2	1.0	**62**	**12**	1.73E+00	0.2	1.0	**8.6**	**1.7**
Vanadium	2.40E+01	5.9	8.3	**4.1**	**2.9**	1.29E+01	5.9	8.3	**2.2**	**1.6**
Zinc	2.97E+01	160	320	0.2	0.1	2.13E+01	160	320	0.1	0.1

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
EDD - Estimated Daily Dose
TRV - Toxicity Reference Values
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.53

Attachment 7.71
Incremental Risk for the Eastern Small-footed Bat at School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site Vershire, VT

	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPEC	SITE-RME	SITE-CTE	REF-RME	REF-CTE	RME	CTE	SITE-RME	SITE-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	0.03	0.05	0.002	0.04	<1	<1	0.01	0.01	3.97E-04	0.01	<1	<1
Arsenic	0.1	0.04	0.1	0.04	<1	<1	0.03	0.02	0.03	0.02	<1	<1
Barium	**1.7**	**1.0**	**2.4**	**1.0**	<1	<1	0.3	0.2	0.5	0.2	<1	<1
Beryllium	0.3	0.1	0.4	0.1	<1	<1	0.07	0.02	0.09	0.03	<1	<1
Cadmium^	-0.001	0.002	0.04	0.002	<1	<1	-0.001	0.001	0.03	0.001	<1	<1
Chromium	0.1	0.1	0.3	0.1	<1	<1	0.02	0.02	0.05	0.02	<1	<1
Cobalt	**10**	**3.3**	0.8	0.6	**9.3**	**2.7**	**2.0**	0.7	0.16	0.1	**1.8**	<1
Copper	**53**	**32**	**1.4**	**1.0**	**52**	**31**	**41**	**25**	**1.1**	0.8	**40**	**24**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.1	0.01	0.02	0.01	<1	<1	0.02	0.01	0.01	0.004	<1	<1
Manganese	**3.3**	**2.2**	**3.0**	**2.2**	<1	<1	**1.0**	0.7	0.9	0.7	<1	<1
Mercury (inorganic)	4.35E-04	5.17E-04	2.54E-04	5.54E-04	<1	<1	1.02E-04	1.22E-04	5.98E-05	1.31E-04	<1	<1
Molybdenum	0.9	0.5	0.1	0.2	<1	<1	0.2	0.1	0.02	0.04	<1	<1
Nickel	0.4	0.3	0.4	0.3	<1	<1	0.3	0.2	0.3	0.2	<1	<1
Selenium	**4.4**	**3.1**	0.1	0.3	**4.3**	**2.8**	**1.5**	**1.0**	0.02	0.09	**1.4**	<1
Silver	0.002	0.002	0.001	0.003	<1	<1	3.50E-04	4.79E-04	2.59E-04	0.001	<1	<1
Thallium	**3.1**	**3.1**	**62**	**8.6**	<1	<1	0.6	0.6	**12**	**1.7**	<1	<1
Vanadium	**5.2**	**2.6**	**4.1**	**2.2**	**1.1**	<1	**3.7**	**1.9**	**2.9**	**1.6**	<1	<1
Zinc	0.3	0.3	0.2	0.1	<1	<1	0.1	0.1	0.09	0.07	<1	<1

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.72
Hazard Quotients for the Eastern Small-footed Bat COPECs at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario Total EDD[1] (mg/kg bw-day)	RME TRV NOAEL	RME TRV LOAEL	RME No Effect HQ	RME Effect HQ	CTE Scenario Total EDD[1] (mg/kg bw-day)	CTE TRV NOAEL	CTE TRV LOAEL	CTE No Effect HQ	CTE Effect HQ
Metals										
Aluminum	1.21E+03	--	--	--	--	6.77E+02	--	--	--	--
Antimony	3.17E-01	13.3	66.5	0.02	0.005	6.51E-01	13.3	66.5	0.05	0.01
Arsenic	5.59E-01	5.7	11.6	0.1	0.05	2.97E-01	5.7	11.6	0.1	0.03
Barium	7.54E+01	51.8	259	**1.5**	0.3	3.88E+01	51.8	259	0.7	0.1
Beryllium	2.07E-01	0.53	2.7	0.4	0.1	4.57E-02	0.53	2.7	0.1	0.02
Cadmium^	-2.62E-02	5.1	7.1	-0.01	-0.004	1.48E-02	5.1	7.1	0.003	0.002
Chromium	1.47E+00	8.8	44.2	0.2	0.03	8.79E-01	8.8	44.2	0.1	0.02
Cobalt	9.64E+01	7.3	36.7	**13**	**2.6**	1.25E+01	7.3	36.7	**1.7**	0.3
Copper	1.56E+02	11.7	15.1	**13**	**10**	9.26E+01	11.7	15.1	**7.9**	**6.1**
Iron	1.44E+03	--	--	--	--	6.78E+02	--	--	--	--
Lead	6.39E-01	34	80	0.02	0.01	3.49E-01	34	80	0.01	0.004
Manganese	2.11E+02	88	284	**2.4**	0.7	1.58E+02	88	284	**1.8**	0.6
Mercury	5.74E-03	13.2	56	4.35E-04	1.03E-04	8.30E-03	13.2	56	0.001	1.48E-04
Molybdenum	1.11E+00	2.6	13	0.4	0.1	9.35E-01	2.6	13	0.4	0.1
Nickel	2.46E+01	60	80	0.4	0.3	1.58E+01	60	80	0.3	0.2
Selenium	1.33E-01	0.35	1.05	0.4	0.1	5.32E-01	0.35	1.05	**1.5**	0.5
Silver	9.03E-02	44.4	222	0.002	4.07E-04	1.15E-01	44.4	222	0.003	0.001
Strontium	1.70E+02	--	--	--	--	1.70E+02	--	--	--	--
Thallium	8.59E+00	0.2	1.0	**43**	**8.6**	2.84E+00	0.2	1.0	**14**	**2.8**
Vanadium	5.51E+01	5.9	8.3	**9.3**	**6.6**	1.09E+01	5.9	8.3	**1.8**	**1.3**
Zinc	4.35E+01	160	320	0.3	0.1	3.23E+01	160	320	0.2	0.1

Note: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the east branch of the Ompompanoosuc River.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value and therefore a negative EDD.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.54

Attachment 7.73
Hazard Quotients for the Eastern Small-footed Bat COPECs at the Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	5.69E+02	--	--	--	--	4.83E+02	--	--	--	--
Antimony	3.35E-02	13.3	66.5	0.003	0.001	6.21E-01	13.3	66.5	0.05	0.01
Arsenic	3.55E-01	5.7	11.6	0.1	0.03	5.53E-01	5.7	11.6	0.1	0.05
Barium	1.57E+02	51.8	259	**3.0**	0.6	6.64E+01	51.8	259	**1.3**	0.3
Beryllium	1.84E-01	0.53	2.7	0.3	0.1	8.66E-02	0.53	2.7	0.2	0.03
Cadmium	2.20E-01	5.1	7.1	0.04	0.03	1.43E-03	5.1	7.1	2.81E-04	2.02E-04
Chromium	1.72E+00	8.8	44.2	0.2	0.04	9.73E-01	8.8	44.2	0.1	0.02
Cobalt	3.72E+00	7.3	36.7	0.5	0.1	1.78E+00	7.3	36.7	0.2	0.05
Copper	5.08E+00	11.7	15.1	0.4	0.3	3.58E+00	11.7	15.1	0.3	0.2
Iron	4.07E+02	--	--	--	--	2.78E+02	--	--	--	--
Lead	5.58E-01	34	80	0.02	0.01	4.37E-01	34	80	0.01	0.01
Manganese	2.11E+02	88	284	**2.4**	0.7	1.24E+02	88	284	**1.4**	0.4
Mercury	7.14E-03	13.2	56	0.001	1.27E-04	4.76E-03	13.2	56	3.61E-04	8.50E-05
Molybdenum	1.62E-01	2.6	13	0.1	0.01	1.62E-01	2.6	13	0.1	0.01
Nickel	1.48E+01	60	80	0.2	0.2	1.03E+01	60	80	0.2	0.1
Selenium	5.01E+00	0.35	1.05	**14**	**4.8**	6.55E-01	0.35	1.05	**1.9**	0.6
Silver	4.44E-02	44.4	222	0.001	2.00E-04	1.21E-01	44.4	222	0.003	0.001
Strontium	1.74E+02	--	--	--	--	1.74E+02	--	--	--	--
Thallium	1.09E+01	0.2	1.0	**55**	**11**	5.65E+00	0.2	1.0	**28**	**5.7**
Vanadium	3.66E+01	5.9	8.3	**6.2**	**4.4**	1.15E+01	5.9	8.3	**2.0**	**1.4**
Zinc	2.44E+01	160	320	0.2	0.1	1.64E+01	160	320	0.1	0.1

Notes: The metals shown in this Attachment are those identified as surface water and sediment COPECs in the impacted reach of EBOR.
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.55

Attachment 7.74
Incremental Risk for the Eastern small-footed bats at the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site Vershire, VT

	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
COPECs	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	0.02	0.05	0.003	0.05	<1	<1	0.005	0.01	0.001	0.01	<1	<1
Arsenic	0.1	0.1	0.1	0.1	<1	<1	0.05	0.03	0.03	0.05	<1	<1
Barium	**1.5**	0.7	**3.0**	**1.3**	<1	<1	0.3	0.1	0.6	0.3	<1	<1
Beryllium	0.4	0.1	0.3	0.2	<1	<1	0.1	0.02	0.07	0.03	<1	<1
Cadmium^	-0.01	0.003	0.04	2.81E-04	<1	<1	-0.004	0.002	0.03	2.02E-04	<1	<1
Chromium	0.2	0.1	0.2	0.1	<1	<1	0.03	0.02	0.04	0.02	<1	<1
Cobalt	**13**	**1.7**	0.5	0.2	**13**	**1.5**	**2.6**	0.3	0.1	0.05	**2.5**	<1
Copper	**13**	**7.9**	0.4	0.3	**13**	**7.6**	**10**	**6.1**	0.3	0.2	**10**	**5.9**
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.02	0.01	0.02	0.01	<1	<1	0.01	0.004	0.01	0.01	<1	<1
Manganese	**2.4**	**1.8**	**2.4**	**1.4**	<1	<1	0.7	0.6	0.7	0.4	<1	<1
Mercury (inorganic)	4.35E-04	0.001	0.001	3.61E-04	<1	<1	1.03E-04	1.48E-04	1.27E-04	8.50E-05	<1	<1
Molybdenum	0.4	0.4	0.1	0.1	<1	<1	0.1	0.1	0.01	0.01	<1	<1
Nickel	0.4	0.3	0.2	0.2	<1	<1	0.3	0.2	0.2	0.1	<1	<1
Selenium	0.4	**1.5**	**14**	**1.9**	<1	<1	0.1	0.5	**4.8**	0.6	<1	<1
Silver	0.002	0.003	0.001	0.003	<1	<1	4.07E-04	0.001	2.00E-04	0.001	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	**43**	**14**	**55**	**28**	<1	<1	**8.6**	**2.8**	**11**	**5.7**	<1	<1
Vanadium	**9.3**	**1.8**	**6.2**	**2.0**	**3.1**	<1	**6.6**	**1.3**	**4.4**	**1.4**	**2.2**	<1
Zinc	0.3	0.2	0.2	0.1	<1	<1	0.1	0.1	0.08	0.05	<1	<1

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
^ - The regression equation used to calculate the cadmium BSAF produced a negative value and therefore a negative HQ.
-- - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
REF - Reference

Attachment 7.75: Weight-of-Evidence Integration for Insectivorous Mammals
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 6:

Maintain stable and healthy insectivorous mammal populations

Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of the insectivorous mammal populations foraging in the vicinity of Schoolhouse Brook and the EBOR?

Measurement Endpoint
6.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water and winged aquatic insects, and compare these values to TRVs.

Weight-of-Evidence Integration

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High		**6.A**			
Yes/Low					
Undeterminate					
No Harm					

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High		**6.A**			
Yes/Low					
Undeterminate					
No Harm					

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the insectivorous mammal populations is discussed in Section 7 of the BERA

Attachment 7.76
Hazard Quotients for Belted Kingfisher COPECs at School House Brook
Ely Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.00E+02	--	--	--	--	5.74E+01	--	--	--	--
Antimony	3.17E-01	--	--	--	--	1.38E-01	--	--	--	--
Arsenic	1.33E-01	5.5	22	0.02	0.01	1.28E-01	5.5	22	0.02	0.01
Barium	9.47E+00	208	416	0.05	0.02	5.84E+00	208	416	0.03	0.01
Beryllium	1.98E-02	--	--	--	--	9.45E-03	--	--	--	--
Cadmium	1.66E-01	1.9	21.1	0.1	0.01	1.66E-01	1.9	21.1	0.1	0.01
Chromium	1.41E+00	37.7	75.4	0.04	0.02	1.17E+00	37.7	75.4	0.03	0.02
Cobalt	6.58E+00	7.61	38.1	0.9	0.2	2.17E+00	7.61	38.1	0.3	0.1
Copper	5.01E+01	33	62	**1.5**	0.8	2.99E+01	33	62	0.9	0.5
Iron	3.62E+02	--	--	--	--	1.04E+02	--	--	--	--
Lead	4.21E-01	7.4	37	0.1	0.01	6.23E-02	7.4	37	0.01	0.002
Manganese	2.87E+01	977	4885	0.03	0.01	1.99E+01	977	4885	0.02	0.004
Mercury	1.79E-02	0.45	0.91	0.04	0.02	1.28E-02	0.45	0.91	0.03	0.01
Molybdenum	3.08E-01	7.1	35.3	0.04	0.01	2.14E-01	7.1	35.3	0.03	0.01
Nickel	2.40E+00	80	107	0.03	0.02	1.54E+00	80	107	0.02	0.01
Selenium	5.26E-01	0.4	0.8	**1.3**	0.7	3.92E-01	0.4	0.8	1.0	0.5
Silver	6.93E-03	14.5	43.6	4.78E-04	1.59E-04	9.48E-03	14.5	43.6	0.001	2.18E-04
Strontium	1.65E+01	--	--	--	--	1.51E+01	--	--	--	--
Vanadium	2.79E+00	11.38	56.9	0.2	0.05	1.43E+00	11.38	56.9	0.1	0.03
Zinc	4.16E+01	14.5	131	**2.9**	0.3	3.54E+01	14.5	131	**2.4**	0.3

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
TRV - Toxicity Reference Value
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.56

Attachment 7.77
Hazard Quotients for Belted Kingfisher COPECs at the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	110	--	--	--	--	62.2	--	--	--	--
Antimony	0.04	--	--	--	--	0.09	--	--	--	--
Arsenic	0.13	5.5	22	0.02	0.01	0.13	5.5	22	0.02	0.01
Barium	11.7	208	416	0.06	0.03	5.2	208	416	0.02	0.01
Beryllium	0.02	--	--	--	--	0.01	--	--	--	--
Cadmium	0.41	1.9	21.1	0.2	0.02	0.17	1.9	21.1	0.09	0.01
Chromium	2.8	37.7	75.4	0.07	0.04	1.4	37.7	75.4	0.04	0.02
Cobalt	1.0	7.61	38.1	0.1	0.03	0.42	7.61	38.1	0.06	0.01
Copper	2.7	33	62	0.08	0.04	1.3	33	62	0.04	0.02
Iron	144	--	--	--	--	55.6	--	--	--	--
Lead	18.2	7.4	37	**2.5**	0.5	11.6	7.4	37	**1.6**	0.3
Manganese	27.8	977	4,885	0.03	0.01	20.0	977	4,885	0.02	0.004
Mercury	0.04	0.45	0.91	0.1	0.05	0.03	0.45	0.91	0.06	0.03
Molybdenum	0.13	7.1	35.3	0.02	0.004	0.15	7.1	35.3	0.02	0.004
Nickel	2.3	80	107	0.03	0.02	1.6	80	107	0.02	0.01
Selenium	0.22	0.4	0.8	0.5	0.3	0.20	0.4	0.8	0.5	0.2
Strontium	20.0	--	--	--	--	17.8	--	--	--	--
Thallium	1.1	--	--	--	--	0.26	--	--	--	--
Vanadium	2.3	11.38	56.9	0.2	0.04	1.2	11.38	56.9	0.1	0.02
Zinc	38.3	14.5	131	**2.6**	0.3	22.7	14.5	131	**1.6**	0.2

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.57

Attachment 7.78
Incremental Risk for Belted Kingfishers at School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.02	0.02	0.02	0.02	<1	<1	0.01	0.01	0.01	0.01	<1	<1
Barium	0.05	0.03	0.1	0.02	<1	<1	0.02	0.01	0.03	0.01	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.1	0.1	0.2	0.1	<1	<1	0.01	0.01	0.02	0.01	<1	<1
Chromium	0.04	0.03	0.1	0.04	<1	<1	0.02	0.02	0.04	0.02	<1	<1
Cobalt	0.9	0.3	0.1	0.1	<1	<1	0.2	0.06	0.03	0.01	<1	<1
Copper	**1.5**	0.9	0.1	0.04	**1.4**	<1	0.8	0.5	0.04	0.02	<1	<1
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.1	0.01	**2.5**	**1.6**	<1	<1	0.01	0.002	0.5	0.3	<1	<1
Manganese	0.03	0.02	0.03	0.02	<1	<1	0.01	0.004	0.01	0.004	<1	<1
Mercury (inorganic)	0.04	0.03	0.1	0.1	<1	<1	0.02	0.01	0.05	0.03	<1	<1
Molybdenum	0.04	0.03	0.02	0.02	<1	<1	0.01	0.01	0.004	0.004	<1	<1
Nickel	0.03	0.02	0.03	0.02	<1	<1	0.02	0.01	0.02	0.01	<1	<1
Selenium	**1.3**	1.0	0.5	0.5	<1	<1	0.7	0.5	0.3	0.2	<1	<1
Silver	4.78E-04	6.54E-04	0.05	0.05	<1	<1	1.59E-04	2.18E-04	0.02	0.02	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.2	0.1	0.2	0.1	<1	<1	0.05	0.03	0.04	0.02	<1	<1
Zinc	**2.9**	**2.4**	**2.6**	**1.6**	<1	<1	0.3	0.3	0.3	0.2	<1	<1

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.79
Hazard Quotients for the Belted Kingfisher COPECs at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

	RME Scenario					CTE Scenario				
COPECs	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.18E+02	--	--	--	--	6.47E+01	--	--	--	--
Antimony	6.30E-02	--	--	--	--	9.34E-02	--	--	--	--
Arsenic	1.54E-01	5.5	22	0.03	0.01	1.33E-01	5.5	22	0.02	0.01
Barium	8.33E+00	208	416	0.04	0.02	4.60E+00	208	416	0.02	0.01
Beryllium	2.22E-02	--	--	--	--	7.79E-03	--	--	--	--
Cadmium	9.19E-02	1.9	21.1	0.05	0.004	1.77E-01	1.9	21.1	0.1	0.01
Chromium	1.65E+00	37.7	75.4	0.04	0.02	1.05E+00	37.7	75.4	0.03	0.01
Cobalt	8.57E+00	7.61	38.1	**1.1**	0.2	1.15E+00	7.61	38.1	0.2	0.03
Copper	1.36E+01	33	62	0.4	0.2	7.93E+00	33	62	0.2	0.1
Iron	1.63E+02	--	--	--	--	8.25E+01	--	--	--	--
Lead	3.63E-02	7.4	37	0.005	0.001	1.99E-02	7.4	37	0.003	0.001
Manganese	2.32E+01	977	4,885	0.02	0.005	1.72E+01	977	4,885	0.02	0.004
Mercury	1.87E-02	0.45	0.91	0.04	0.02	1.50E-02	0.45	0.91	0.03	0.02
Molybdenum	2.03E-01	7.1	35.3	0.03	0.01	1.88E-01	7.1	35.3	0.03	0.01
Nickel	2.32E+00	80	107	0.03	0.02	1.45E+00	80	107	0.02	0.01
Selenium	1.86E-01	0.4	0.8	0.5	0.2	2.41E-01	0.4	0.8	0.6	0.3
Silver	7.98E-03	14.5	43.6	0.001	1.83E-04	1.02E-02	14.5	43.6	0.001	2.35E-04
Strontium	1.50E+01	--	--	--	--	1.50E+01	--	--	--	--
Thallium	7.70E-01	--	--	--	--	2.61E-01	--	--	--	--
Vanadium	4.94E+00	11.38	56.9	0.4	0.1	1.03E+00	11.38	56.9	0.1	0.02
Zinc	4.09E+01	14.5	131	**2.8**	0.3	3.22E+01	14.5	131	**2.2**	0.2

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the impacted reach of the EBOR.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachmen 5.58

Attachment 7.80
Hazard Quotients for the Belted Kingfisher COPECs at the Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	5.65E+01	--	--	--	--	4.71E+01	--	--	--	--
Antimony	7.29E-02	--	--	--	--	1.02E-01	--	--	--	--
Arsenic	1.45E-01	5.5	22	0.03	0.01	1.58E-01	5.5	22	0.03	0.01
Barium	1.54E+01	208	416	0.07	0.04	7.37E+00	208	416	0.04	0.02
Beryllium	2.02E-02	--	--	--	--	1.15E-02	--	--	--	--
Cadmium	3.86E-01	1.9	21.1	0.20	0.02	1.44E-01	1.9	21.1	0.1	0.01
Chromium	1.97E+00	37.7	75.4	0.05	0.03	1.19E+00	37.7	75.4	0.03	0.02
Cobalt	3.43E-01	7.61	38.1	0.05	0.01	1.69E-01	7.61	38.1	0.02	0.004
Copper	1.11E+00	33	62	0.03	0.02	6.91E-01	33	62	0.02	0.01
Iron	5.94E+01	--	--	--	--	4.62E+01	--	--	--	--
Lead	3.02E-02	7.4	37	0.004	0.001	2.53E-02	7.4	37	0.003	0.001
Manganese	2.25E+01	977	4885	0.02	0.005	1.46E+01	977	4885	0.01	0.003
Mercury	2.22E-02	0.45	0.91	0.05	0.02	1.83E-02	0.45	0.91	0.04	0.02
Molybdenum	1.19E-01	7.1	35.3	0.02	0.003	1.19E-01	7.1	35.3	0.02	0.003
Nickel	1.45E+00	80	107	0.02	0.01	1.05E+00	80	107	0.01	0.01
Selenium	1.34E+00	0.4	0.8	**3.3**	**1.7**	2.82E-01	0.4	0.8	0.7	0.4
Silver	3.92E-03	14.5	43.6	2.70E-04	8.99E-05	1.07E-02	14.5	43.6	0.001	2.45E-04
Strontium	1.54E+01	--	--	--	--	1.54E+01	--	--	--	--
Thallium	9.76E-01	--	--	--	--	5.10E-01	--	--	--	--
Vanadium	3.30E+00	11.38	56.9	0.3	0.06	1.09E+00	11.38	56.9	0.1	0.02
Zinc	3.62E+01	14.5	131	**2.5**	0.3	3.16E+01	14.5	131	**2.2**	0.2

Note: The metals shown in this Attachment are those identified as surface water, fish, and sediment COPECs in the east branch of the Ompompanoosuc River.
mg/kg - milligrams per kilogram
ug/L - micrograms per liter
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.59

Attachment 7.81
Incremental Risk for the Belted Kingfishers at the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site Vershire, VT

COPECs	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.03	0.02	0.03	0.03	<1	<1	0.01	0.01	0.01	0.01	<1	<1
Barium	0.04	0.02	0.1	0.04	<1	<1	0.02	0.01	0.04	0.02	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.05	0.1	0.2	0.1	<1	<1	0.004	0.01	0.02	0.01	<1	<1
Chromium	0.04	0.03	0.1	0.03	<1	<1	0.02	0.01	0.03	0.02	<1	<1
Cobalt	**1.1**	0.2	0.05	0.02	**1**	<1	0.2	0.03	0.01	0.004	<1	<1
Copper	0.4	0.2	0.03	0.02	<1	<1	0.2	0.1	0.02	0.01	<1	<1
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.005	0.003	0.004	0.003	<1	<1	0.001	0.001	0.001	0.001	<1	<1
Manganese	0.02	0.02	0.02	0.01	<1	<1	0.005	0.004	0.005	0.003	<1	<1
Mercury	0.04	0.03	0.05	0.04	<1	<1	0.02	0.02	0.02	0.02	<1	<1
Molybdenum	0.03	0.03	0.02	0.02	<1	<1	0.01	0.01	0.003	0.003	<1	<1
Nickel	0.03	0.02	0.02	0.01	<1	<1	0.02	0.01	0.01	0.01	<1	<1
Selenium	0.5	0.6	**3.3**	0.7	<1	<1	0.2	0.3	**1.7**	0.4	<1	<1
Silver	0.001	0.001	2.70E-04	0.001	<1	<1	1.83E-04	2.35E-04	8.99E-05	2.45E-04	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.4	0.1	0.3	0.1	<1	<1	0.1	0.02	0.06	0.02	<1	<1
Zinc	**2.8**	**2.2**	**2.5**	**2.2**	<1	<1	0.3	0.2	0.3	0.2	<1	<1

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
-- - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
REF - Reference

Attachment 7.82: Weight-of-Evidence Integration for Piscivorous Birds
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 7:
Maintain stable and healthy piscivorous bird populations
Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of the piscivorous bird populations foraging in the vicinity of Schoolhouse Brook and the EBOR?

Measurement Endpoint
7.A: Use food chain modeling to calculate the mean and maximum daily doses to belted kingfishers from ingesting surface water and fish, and compare these values to TRVs

Weight-of-Evidence Integration

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm			**7.A**		

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm			**7.A**		

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the piscivorous bird populations is discussed in Section 7 of the BERA

Attachment 7.83
Hazard Quotients for Mink COPECs at
School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	2.52E+00	--	--	--	--	1.17E+00	--	--	--	--
Antimony	7.99E-02	13.3	66.5	0.01	0.001	2.46E-02	13.3	66.5	0.002	3.70E-04
Arsenic	2.99E-02	5.7	11.6	0.01	0.003	3.31E-02	5.7	11.6	0.006	0.003
Barium	4.63E-01	51.8	259	0.01	0.002	3.58E-01	51.8	259	0.007	0.001
Cadmium	7.56E-03	5.1	7.1	0.001	0.001	4.23E-03	5.1	7.1	8.29E-04	5.96E-04
Chromium	9.17E-03	8.8	44.2	0.001	2.08E-04	7.08E-03	8.8	44.2	8.05E-04	1.60E-04
Cobalt	2.26E-02	7.3	36.7	0.003	6.16E-04	1.18E-02	7.3	36.7	0.002	3.20E-04
Copper	1.60E+00	11.7	15.1	0.1	0.1	9.23E-01	11.7	15.1	0.08	0.1
Iron	9.41E+00	--	--	--	--	6.97E+00	--	--	--	--
Lead	2.34E-01	34	80	0.01	0.003	2.99E-02	34	80	8.78E-04	3.73E-04
Manganese	8.51E-01	88	284	0.01	0.003	7.23E-01	88	284	0.01	0.003
Mercury	1.06E-03	13.2	56	8.06E-05	1.90E-05	6.46E-04	13.2	56	4.90E-05	1.15E-05
Molybdenum	2.99E-02	2.6	13	0.01	0.002	3.01E-02	2.6	13	0.01	0.002
Nickel	4.02E-02	60	80	0.001	5.03E-04	3.47E-02	60	80	5.78E-04	4.33E-04
Selenium	5.77E-02	0.35	1.05	0.2	0.05	4.69E-02	0.35	1.05	0.1	0.04
Silver	6.63E-05	44.4	222	1.49E-06	2.99E-07	9.62E-05	44.4	222	2.17E-06	4.33E-07
Strontium	1.58E-02	--	--	--	--	1.41E-02	--	--	--	--
Vanadium	2.00E-02	5.9	8.3	0.003	0.002	2.02E-02	5.9	8.3	0.003	0.002
Zinc	8.16E+00	160	320	0.1	0.03	6.81E+00	160	320	0.04	0.02

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
TRV - Toxicity Reference Value
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.60

Attachment 7.84
Hazard Quotients for Mink COPECs in the Reference Section of School House Brook
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario Total EDD[1] (mg/kg bw-day)	RME TRV NOAEL	RME TRV LOAEL	RME No Effect HQ	RME Effect HQ	CTE Scenario Total EDD[1] (mg/kg bw-day)	CTE TRV NOAEL	CTE TRV LOAEL	CTE No Effect HQ	CTE Effect HQ
Metals										
Aluminum	5.35E+00	--	--	--	--	1.88E+00	--	--	--	--
Antimony	9.98E-03	13.3	66.5	7.51E-04	1.50E-04	1.11E-02	13.3	66.5	8.34E-04	1.67E-04
Arsenic	2.99E-02	5.7	11.6	0.005	0.003	3.31E-02	5.7	11.6	0.006	0.003
Barium	2.27E-01	51.8	259	0.004	8.78E-04	1.18E-01	51.8	259	0.002	4.54E-04
Cadmium	8.62E-03	5.1	7.1	0.002	0.001	5.34E-03	5.1	7.1	0.001	7.52E-04
Chromium	1.11E-02	8.8	44.2	0.001	2.50E-04	8.47E-03	8.8	44.2	9.63E-04	1.92E-04
Cobalt	1.20E-02	7.3	36.7	0.002	3.28E-04	8.68E-03	7.3	36.7	0.001	2.36E-04
Copper	3.79E-01	11.7	15.1	0.03	0.03	2.88E-01	11.7	15.1	0.02	0.02
Iron	7.55E-02	--	--	--	--	2.01E-02	--	--	--	--
Lead	1.21E+01	34	80	0.4	0.2	7.70E+00	34	80	0.2	0.1
Manganese	1.22E+00	88	284	0.01	0.004	7.62E-01	88	284	0.009	0.003
Mercury	3.00E-03	13.2	56	2.27E-04	5.36E-05	1.79E-03	13.2	56	1.35E-04	3.19E-05
Molybdenum	3.00E-02	2.6	13	0.01	0.002	3.00E-02	2.6	13	0.01	0.002
Nickel	4.00E-02	60	80	6.66E-04	5.00E-04	2.86E-02	60	80	4.77E-04	3.58E-04
Selenium	7.98E-02	0.35	1.05	0.2	0.08	6.34E-02	0.35	1.05	0.2	0.06
Silver	2.48E-04	44.4	222	5.57E-06	1.11E-06	4.32E-05	44.4	222	9.72E-07	1.94E-07
Strontium	1.67E-02	--	--	--	--	1.37E-02	--	--	--	--
Vanadium	4.00E-02	5.9	8.3	0.007	0.005	2.86E-02	5.9	8.3	0.005	0.003
Zinc	6.77E+00	160	320	0.04	0.02	4.87E+00	160	320	0.03	0.02

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the impacted reach of School House Brook.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
TRV - Toxicity Reference Value
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachmen 5.61

Attachment 7.85
Incremental Risk for Mink at School House Brook
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPEC	No Effect Scenario						Effect Scenario					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	0.01	0.002	0.001	0.001	<1	<1	0.001	3.70E-04	1.50E-04	1.67E-04	<1	<1
Arsenic	0.01	0.01	0.01	0.01	<1	<1	0.003	0.003	0.003	0.003	<1	<1
Barium	0.01	0.01	0.004	0.002	<1	<1	0.002	0.001	0.001	4.54E-04	<1	<1
Cadmium	1.48E-03	8.29E-04	0.002	0.001	<1	<1	0.001	5.96E-04	0.001	0.001	<1	<1
Chromium	1.04E-03	8.05E-04	0.001	0.001	<1	<1	2.08E-04	1.60E-04	2.50E-04	1.92E-04	<1	<1
Cobalt	0.003	0.002	0.002	0.001	<1	<1	6.16E-04	3.20E-04	3.28E-04	2.36E-04	<1	<1
Copper	0.1	0.08	0.03	0.02	<1	<1	0.1	0.1	0.03	0.02	<1	<1
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.01	0.001	0.35	0.23	<1	<1	0.003	3.73E-04	0.2	0.1	<1	<1
Manganese	0.01	0.01	0.01	0.01	<1	<1	0.003	0.003	0.004	0.003	<1	<1
Mercury (inorganic)	8.06E-05	4.90E-05	2.27E-04	1.35E-04	<1	<1	1.90E-05	1.15E-05	5.36E-05	3.19E-05	<1	<1
Molybdenum	0.01	0.01	0.01	0.01	<1	<1	0.002	0.002	0.002	0.002	<1	<1
Nickel	6.71E-04	5.78E-04	0.001	4.77E-04	<1	<1	5.03E-04	4.33E-04	5.00E-04	3.58E-04	<1	<1
Selenium	0.2	0.1	0.2	0.2	<1	<1	0.05	0.04	0.08	0.06	<1	<1
Silver	1.49E-06	2.17E-06	5.57E-06	9.72E-07	<1	<1	2.99E-07	4.33E-07	1.11E-06	1.94E-07	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.003	0.003	0.01	0.005	<1	<1	0.002	0.002	0.005	0.003	<1	<1
Zinc	0.05	0.04	0.04	0.03	<1	<1	0.03	0.02	0.02	0.02	<1	<1

COPEC - Chemical of Potential Ecological Concern

* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.

RME - Reasonable Maximum Exposure

CTE - Central Tendency Exposure

REF - Reference

Attachment 7.86
Hazard Quotients for Mink COPECs at the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	3.39E+00	--	--	--	--	1.44E+00	--	--	--	--
Antimony	1.01E-02	13.3	66.5	0.001	1.51E-04	1.10E-02	13.3	66.5	0.001	1.65E-04
Arsenic	2.99E-02	5.7	11.6	0.01	0.003	3.25E-02	5.7	11.6	0.01	0.00
Barium	4.79E-01	51.8	259	0.01	0.002	3.36E-01	51.8	259	0.01	0.001
Cadmium	7.55E-03	5.1	7.1	0.001	0.001	4.67E-03	5.1	7.1	0.001	0.001
Chromium	5.51E-03	8.8	44.2	0.001	1.25E-04	5.12E-03	8.8	44.2	0.001	1.16E-04
Cobalt	1.80E-02	7.3	36.7	0.002	4.91E-04	1.38E-02	7.3	36.7	0.002	3.76E-04
Copper	7.01E-01	11.7	15.1	0.06	0.05	4.18E-01	11.7	15.1	0.04	0.03
Iron	1.02E+01	--	--	--	--	6.47E+00	--	--	--	--
Lead	8.02E-03	34	80	2.36E-04	1.00E-04	4.56E-03	34	80	1.34E-04	5.70E-05
Manganese	1.29E+00	88	284	0.01	0.005	9.30E-01	88	284	0.01	0.003
Mercury	1.12E-03	13.2	56	8.46E-05	1.99E-05	7.45E-04	13.2	56	5.65E-05	1.33E-05
Molybdenum	2.99E-02	2.6	13	0.01	0.002	3.00E-02	2.6	13	0.01	0.002
Nickel	4.00E-02	60	80	0.001	5.01E-04	2.90E-02	60	80	4.84E-04	3.63E-04
Selenium	5.74E-02	0.35	1.05	0.16	0.05	4.14E-02	0.35	1.05	0.1	0.04
Strontium	1.48E-02	--	--	--	--	1.28E-02	--	--	--	--
Vanadium	2.00E-02	5.9	8.3	0.003	0.002	2.03E-02	5.9	8.3	0.003	0.002
Zinc	8.36E+00	160	320	0.1	0.03	6.72E+00	160	320	0.04	0.02

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the east branch of the Ompompanoosuc River.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EDD - Estimated Daily Dose
EBOR - East Branch of the Ompompanoosuc River
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotient could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachment 5.62

Attachment 7.87
Hazard Quotients for Mink COPECs at the Reference Section of the EBOR
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	RME Scenario					CTE Scenario				
	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ	Total EDD[1] (mg/kg bw-day)	TRV NOAEL	TRV LOAEL	No Effect HQ	Effect HQ
Metals										
Aluminum	1.81E+00	--	--	--	--	1.29E+00	--	--	--	--
Antimony	2.00E-02	13.3	66.5	0.002	3.00E-04	1.42E-02	13.3	66.5	0.001	2.14E-04
Arsenic	3.98E-02	5.7	11.6	0.01	0.003	3.45E-02	5.7	11.6	0.01	0.003
Barium	4.65E-01	51.8	259	0.01	0.002	4.32E-01	51.8	259	0.01	0.002
Cadmium	4.56E-03	5.1	7.1	0.001	6.42E-04	3.08E-03	5.1	7.1	0.001	4.34E-04
Chromium	7.31E-03	8.8	44.2	0.001	1.65E-04	6.36E-03	8.8	44.2	0.001	1.44E-04
Cobalt	4.01E-03	7.3	36.7	0.001	1.09E-04	3.52E-03	7.3	36.7	4.82E-04	9.59E-05
Copper	4.19E-01	11.7	15.1	0.04	0.03	2.46E-01	11.7	15.1	0.02	0.02
Iron	6.71E+00	--	--	--	--	6.18E+00	--	--	--	--
Lead	6.03E-03	34	80	1.77E-04	7.54E-05	6.03E-03	34	80	1.77E-04	7.54E-05
Manganese	1.10E+00	88	284	0.01	0.004	1.06E+00	88	284	0.01	0.004
Mercury	1.30E-03	13.2	56	9.86E-05	2.32E-05	1.12E-03	13.2	56	8.48E-05	2.00E-05
Molybdenum	2.99E-02	2.6	13	0.01	0.002	3.00E-02	2.6	13	0.01	0.002
Nickel	4.00E-02	60	80	0.001	5.00E-04	4.01E-02	60	80	0.001	0.001
Selenium	4.57E-02	0.35	1.05	0.1	0.04	4.55E-02	0.35	1.05	0.1	0.04
Strontium	1.95E-02	--	--	--	--	1.32E-02	--	--	--	--
Vanadium	2.00E-02	5.9	8.3	0.003	0.002	2.00E-02	5.9	8.3	0.003	0.002
Zinc	8.48E+00	160	320	0.1	0.03	7.78E+00	160	320	0.05	0.02

Note: The metals shown in this Attachment are those identified as fish tissue and surface water COPECs in the east branch of the Ompompanoosuc River.
mg/kg bw-day - milligrams per kilogram of body weight per day
COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
EDD - Estimated Daily Dose
NOAEL - No Observable Adverse Effect Level
LOAEL - Lowest Observable Adverse Effect Level
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
HQ - Hazard Quotient
-- - A hazard quotientHQ could not be calculated because no TRV was available.
1 - Total EDD is calculated in Attachmen 5.63

Attachment 7.88
Incremental Risk for the Mink at the EBOR
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site, Vershire, VT

COPECs	No Effect						Effect					
	Hazard Quotient				Incremental Risk*		Hazard Quotient				Incremental Risk*	
	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE	Site-RME	Site-CTE	REF-RME	REF-CTE	RME	CTE
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	0.001	0.001	0.002	0.001	<1	<1	1.51E-04	1.65E-04	3.00E-04	2.14E-04	<1	<1
Arsenic	0.01	0.01	0.01	0.01	<1	<1	0.003	0.003	0.003	0.003	<1	<1
Barium	0.01	0.01	0.01	0.01	<1	<1	0.002	0.001	0.002	0.002	<1	<1
Cadmium	0.001	0.001	0.001	0.001	<1	<1	0.001	0.001	0.001	4.34E-04	<1	<1
Chromium	0.001	0.001	0.001	0.001	<1	<1	1.25E-04	1.16E-04	1.65E-04	1.44E-04	<1	<1
Cobalt	0.002	0.002	0.001	4.82E-04	<1	<1	4.91E-04	3.76E-04	1.09E-04	9.59E-05	<1	<1
Copper	0.1	0.0	0.04	0.02	<1	<1	0.05	0.03	0.03	0.02	<1	<1
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	2.36E-04	1.34E-04	1.77E-04	1.77E-04	<1	<1	1.00E-04	5.70E-05	7.54E-05	7.54E-05	<1	<1
Manganese	0.01	0.01	0.01	0.01	<1	<1	0.005	0.003	0.004	0.004	<1	<1
Mercury (inorganic)	8.46E-05	5.65E-05	9.86E-05	8.48E-05	<1	<1	1.99E-05	1.33E-05	2.32E-05	2.00E-05	<1	<1
Molybdenum	0.01	0.01	0.01	0.01	<1	<1	0.002	0.002	0.002	0.002	<1	<1
Nickel	0.001	0.000	0.001	0.001	<1	<1	0.001	3.63E-04	5.00E-04	0.001	<1	<1
Selenium	0.2	0.1	0.1	0.1	<1	<1	0.05	0.04	0.04	0.04	<1	<1
Strontium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.003	0.003	0.003	0.003	<1	<1	0.002	0.002	0.002	0.002	<1	<1
Zinc	0.1	0.0	0.1	0.05	<1	<1	0.03	0.02	0.03	0.02	<1	<1

COPECs - Chemicals of Potential Ecological Concern
EBOR - East Branch of the Ompompanoosuc River
* - The incremental risk is the hazard quotient calculated for the Site minus the hazard quotient calculated for the reference area.
-- - Not Available
RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
REF - Reference

Attachment 7.89: Weight-of-Evidence Integration for Piscivorous Mammals
Baseline Ecological Risk Assessment
Ely Copper Mine Superfund Site
Vershire, VT

Assessment Endpoint 8:
Maintain stable and healthy piscivorous mammal populations
Are the COPEC levels in surface water and biota sufficiently high to cause biologically-significant changes or impair the function of the piscivorous mammal populations foraging in the vicinity of Schoolhouse Brook and the EBOR?

Measurement Endpoint
8.A: Use food chain modeling to calculate the mean and maximum daily doses to mink from ingesting surface water and fish, and compare these values to TRVs

Weight-of-Evidence Integration

Schoolhouse Brook

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm			**8.A**		

The EBOR

	WEIGHT OF EVIDENCE				
HARM/MAGNITUDE	Low	Low - Medium	Medium	Medium - High	High
Yes/High					
Yes/Low					
Undeterminate					
No Harm			**8.A**		

Assessment endpoints, measurement endpoints, and assigned weights are discussed in Section 4 of the BERA
The WOE integration for the piscivorous mammal populations is discussed in Section 7 of the BERA

Table 7.90: Overview of the major uncertainties associated with the risk characterization for the Ely Copper Mine BERA		
Measurement Endpoint	**Qualitative Description of Uncertainty**	**Potential Effect on Risk**
BENTHIC INVERTEBRATE COMMUNITY		
Measurement endpoint 1.A: Compare COPEC levels in bulk sediment to benchmarks.	The sampling locations can affect contaminant levels. Sediment samples were collected throughout the waterways, including depositional areas, over several years. It is unlikely that "hotspots" were missed.	No effect on risk
	The toxicity-based, literature-derived sediment benchmarks were generic but conservative values which did not consider site-specific factors (e.g., AVS/SEM, TOC, other binding phases) that may affect bioavailability *in-situ*.	Up to moderate overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs.	Small underestimation of risk
	Digesting sediment samples with strong acid prior to chemical analyses did not liberate COPECs in a way which mimicked the exposure experienced by benthic invertebrates in the field.	Moderate overestimation of risk
	Sediment benchmarks were available for all the COPECs.	Minimal effect on risk
	The sediment benchmarks did not account for low pH surface water or pore water that may affect benthic invertebrates at certain times of the year, independent from the COPEC levels in the substrate.	Up to moderate underestimation of risk
	Most of the substrate in the affected waterways consisted mainly of sand, gravel, and boulders. Much of the benthos was expected to live under rocks and in small crevices where exposure would be to COPECs in surface water, more than in pore water or bulk sediment.	Unknown effect on risk
	Overall potential effect on ecological risk	***Moderate overestimation***
Measurement endpoint 1.B: Compare dissolved COPEC levels in pore water to benchmarks.	Pore water chemistry varies by season, location, surface water quality, and substrate conditions. Only a few pore water samples were collected during low (summer) flow from each waterway. Such samples were unlikely to represent the full range of pore water conditions.	Moderate to severe underestimation of risk (but only during high flow)
	Toxicity-based surface water benchmarks from the literature represented generic but conservative values protective of a small fraction of the most sensitive species.	Small overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs	Small underestimation of risk
	Surface water benchmarks were available for all of the COPECs.	Minimal effect on risk
	Dissolved metals data were compared to the benchmarks. Dissolved metals represent the fraction responsible for toxicity in aquatic receptors.	Minimal effect on risk
	The surface water benchmarks do not account for low pH surface water or pore water that may affect benthic invertebrates at certain times of the year independent from the COPEC levels in the substrate.	Up to moderate underestimation of risk
	Overall potential effect on ecological risk	***Moderate underestimation***
Measurement endpoint 1.C: Estimate COPEC bioavailability based on AVS and SEM.	AVS and SEM can vary by season to to changes in water flow and temperature. Samples were collected mostly in the summer and fall.	Unknown effect on risk
	AVS levels can be diminished due to oxidation during sample collection and storage. This was unlikely to be a serious issue at the study sites because AVS was minimal to begin with.	Up to small overestimation of risk
	AVS > SEM does not necessarily indicate the presence of toxicity (EPA, 2005b)	small to moderate overestimation of risk
	Overall potential effect on ecological risk evaluation	***small to moderate overestimation***

Table 7.90: Overview of the major uncertainties associated with the risk characterization for the Ely Copper Mine BERA		
Measurement Endpoint	**Qualitative Description of Uncertainty**	**Potential Effect on Risk**
Measurement endpoint 1.D: Toxicity testing of juvenile *H. azteca* and *C. tentans* exposed to pore water in the laboratory.	Pore water chemistry varies by season, location, surface water quality, and substrate conditions. Only a few pore water samples were collected during summer base flow from each waterway. These samples were unlikely to represent the full range of pore water conditions.	Moderate to severe underestimation of risk (but only during high flow)
	Contaminant sensitivity is species-specific. *H. azteca* is considered relatively sensitive to metals; *C. tentans* less so. It is not known how the response of *H. azteca* to metals compares to that of sensitive local benthic invertebrates in the waterways.	Unknown effect on risk
	Using sensitive juvenile life stages increased the chances of detecting toxicity, whereas the short duration of the test (96 hours) decreased the chances of detecting longer-term impacts, such as on growth or reproduction.	Moderate underestimation of risk
	A white floc was observed in the pore water samples used for the daily renewals. It seemed likely that changes in water chemistry caused dissolved metals to precipitate out of solution thereby affecting the measured pore water toxicity.	Small underestimation of risk
	Overall potential effect on ecological risk	***Moderate to severe underestimation***
Measurement endpoint 1.E: Toxicity testing of *H. azteca* and *C. tentans* exposed to sediment in the laboratory.	The sampling locations can affect contaminant levels. Sediment samples were collected from the few available depositional areas in each waterway which are more likely to accumulate metals in sediment.	Overestimation of risk by focusing on the few depositional areas
	Contaminant sensitivity is species-specific. *H. azteca* is considered relatively sensitive to metals; *C. tentans* less so. It was not known how the response of *H. azteca* to metals compared to that of sensitive local benthic invertebrates in the waterways.	Unknown effect on risk
	The conditions in the test beakers were different from those found *in-situ*. The coarse nature of the sediment and the more settled conditions in the beakers could have allowed metals to more readily dissociate from the sediment and accumulate in the pore water. On the other hand, changes in chemistry could have caused those metals to precipitate out of solution and become less bioavailable.	Unknown effect on risk
	Using sensitive juvenile life stages increased the chances of detecting toxicity, whereas the relatively short duration of the test (28 days for *H. azteca* and 10 days for *C. tentans*) decreased the chances of detecting long-term effects, such as on reproduction.	Small underestimation of risk
	Overall potential effect on ecological risk	***Up to moderate overestimation***
Measurement endpoint 1.F: Benthic community surveys.	Benthic invertebrate surveys can generate results which are highly variable and difficult to interpret. The fact that the surveys were performed using approved sampling and statistical analyses protocols minimized these concerns.	Minimal effect on risk
	The survey occurred during summer base flow when the surface and pore water are least toxic. However, the structure of the benthic community at the sampling locations represents a chronic response of chemical conditions integrated over time.	Minimal effect on risk
	The published benthic community metrics used in the field data interpretation were obtained from VT streams with physical and hydrologic characteristics similar to those found in the waterways at the Site.	Minimal effect on risk
	Overall potential effect on ecological risk	***Risk was as reported***

Table 7.90: Overview of the major uncertainties associated with the risk characterization for the Ely Copper Mine BERA		
Measurement Endpoint	**Qualitative Description of Uncertainty**	**Potential Effect on Risk**
WATER COLUMN INVERTEBRATE COMMUNITY IN THE PONDS		
Measurement endpoint 2.A: compare surface water COPECs to benchmarks.	Surface water chemistry varies significantly by season and location. Surface water samples were collected mainly in May and June. The surface water data sets for the ponds likely did not represent the full range of surface water conditions experienced by water column invertebrates in these habitats.	Small to moderate underestimation of risk (but only during high flow)
	Toxicity-based surface water benchmarks from the literature represented generic but conservative values protective of a small fraction of the most sensitive species.	Small overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs	Small underestimation of risk
	Toxicity-based surface water benchmarks were available for all of the COPECs.	No effect on risk
	Dissolved metals data were compared to the benchmarks. Dissolved metals represent the fraction responsible for toxicity in aquatic receptors.	Minimal effect on risk
	The surface water benchmarks do not account for low pH conditions that may have affected water column invertebrates at certain times of the year, independent from the COPEC levels in the surface water	Moderate underestimation of risk
	Overall potential effect on ecological risk	***Moderate underestimation***
FISH COMMUNITY		
Measurement endpoint 3.A: Compare dissolved COPEC levels in surface water to benchmarks.	Surface water chemistry varies significantly by season and location. However, numerous surface water samples were collected from the three streams between March and November over several years. The surface water data sets reflect the full range of chemical conditions experienced by fish in these habitats.	minimal effect on risk
	Toxicity-based surface water benchmarks from the literature represented generic but conservative values protective of a small fraction of the most sensitive species.	Small overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs.	Small underestimation of risk
	Toxicity-based surface water benchmarks were available for all of the COPECs.	Minimal effect on risk
	Dissolved metals data were compared to the benchmarks. Dissolved metals represent the fraction responsible for toxicity in aquatic receptors.	Minimal effect on risk
	The surface water benchmarks did not account for low pH conditions that may affect water column invertebrates at certain times of the year, independent from the COPEC levels in the surface water.	Up to moderate underestimation of risk
	Overall potential effect on ecological risk	***Small to moderate underestimation***
Measurement endpoint 3.B: Expose juvenile fathead minnows (*P. promelas*) to surface water in the laboratory.	Surface water chemistry varies by season and location. The surface water samples were collected over three days in late June 2006. These samples did not represent the full range of surface water conditions in the ponds and the waterways.	Up to severe underestimation of risk (but only during high flow)
	Contaminant sensitivity is species-specific. *P. promelas was* considered relatively sensitive to metals. It was not known how the response of *P. promelas* compared to that of sensitive local fish species in the waterways.	Unknown effect on risk
	Using sensitive juvenile life stages increased the chances of detecting toxicity, whereas the short duration of the test (7 days) decreased the chances of detecting long-term impacts, such as on reproduction.	Small underestimation of risk
	A white floc was observed in the surface water samples used for the daily renewals. It was likely that changes in water chemistry caused dissolved metals to precipitate out of solution thereby affecting the toxicity of the pore water.	Small underestimation of risk
	Overall potential effect on ecological risk	***Moderate underestimation***

Table 7.90: Overview of the major uncertainties associated with the risk characterization for the Ely Copper Mine BERA		
Measurement Endpoint	**Qualitative Description of Uncertainty**	**Potential Effect on Risk**
Measurement endpoint 3.C: Compare COPEC levels in fish tissue to CBRs.	The metal residues in fish collected from the affected waterways reflected chronic exposures to COPECs in surface water, sediment, and food integrated over time.	Minimal effect on risk
	Fish with excessively high body burdens of metals may have died and would have been excluded from the tissue residue database.	Small to moderate underestimation of risk
	The CBRs were derived from published salmonid data (mostly rainbow trout). Brook trout are a target species in the affected waterways. It is unknown if other fish species (including blacknose dace) present in the affected waterways were more or less sensitive than rainbow trout.	Unknown effect on risk
	The CBRs were conservative values obtained from the literature. The geometric mean was used to calculate species-specific CBRs. The geometric mean of all of these species-specific geometric means was used to calculate the final CBRs. This approach was conservative.	moderate overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk associated with the presence of multiple COPECs.	Small underestimation of risk
	Overall potential effect on ecological risk	***Up to moderate overestimation***
Measurement endpoint 3.D: Fish community survey	The survey occurred during summer base flow when the surface water was least toxic. However, the overall structure of the fish community at the sampling locations in the waterways represented a long-term, chronic response to chemical conditions integrated over multiple years.	Minimal to no effect on risk
	Fish composition can be underestimated if uncommon species are missed during sampling. This variable should only have had a minor effect on the data because Schoolhouse Brook and the EBOR represent relatively shallow and simple sampling habitats.	Minimal to no effect on risk
	The published fish community metrics used in the field data interpretation were obtained from VT streams with physical and hydrologic characteristics similar to those found in the waterways at the Site.	Minimal to no effect on risk
	Overall potential effect on ecological risk	***Risk was as reported***
	AMPHIBIAN POPULATIONS	
Measurement endpoint 4.A: Compare dissolved COPEC levels in surface water to benchmarks.	Surface water samples were collected weekly during the time period (May-June) when the local amphibian populations used the ponds for breeding. The COPEC levels represented typical exposure conditions experienced during breeding.	No effect on risk
	Toxicity-based surface water benchmarks from the literature represented generic but conservative values protective of a small fraction of the most sensitive aquatic species.	Potential for up to moderate overestimation of risk
	Toxicity-based surface water benchmarks were available for all of the COPECs.	Minimal effect on risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs.	Small underestimation of risk
	Dissolved metals data were compared to the benchmarks. Dissolved metals represent the fraction responsible for toxicity in aquatic receptors.	Minimal effect on risk
	The surface water benchmarks did not account for low pH conditions that may affect the tadpoles of local amphibian populations independently from the COPEC levels in the surface water.	Up to moderate underestimation of risk
	Overall potential effect on ecological risk	***Slight underestimation***
Measurement endpoint 4.B: Expose juvenile fathead minnows (surrogates for amphibian embryo-larvae) to surface water in the laboratory.	Surface water chemistry varies over time. The surface water samples were collected over three days in late June 2006. These samples may not represent the full range of surface water conditions in the ponds during the amphibian breeding season (May-June).	Potential for up to moderate underestimation of risk
	Contaminant sensitivity is species-specific. *P. promelas* was considered relatively sensitive to metals. It was not known how the response of this species compared to that of the larval stages of the amphibian species breeding in the ponds.	Unknown effect on risk, but potential for underestimation
	Using sensitive juvenile life stages increased the chances of detecting toxicity, whereas the short duration of the test (7 days) decreased the chances of detecting long-term impacts, such as on reproduction.	Small underestimation of risk
	A white floc was observed in the surface water samples used for the daily renewals. It was likely that changes in water chemistry caused dissolved metals to precipitate out of solution thereby affecting the toxicity of the pore water.	Small underestimation of risk
	Overall potential effect on ecological risk	***Up to moderate underestimation***

Table 7.90: Overview of the major uncertainties associated with the risk characterization for the Ely Copper Mine BERA		
Measurement Endpoint	**Qualitative Description of Uncertainty**	**Potential Effect on Risk**
Measurement endpoint 4.C: *in-situ* toxicity testing (wood frog eggs and tadpoles)	The exposures took place during the time period (early May) when the local amphibian populations used the ponds for breeding. The physical-chemical environment in the ponds represented typical exposure conditions experienced in the spring.	No effect on risk
	The physical and chemical conditions inside the inner Nytex cages may have caused some of the dissolved metals to precipitate out or bind to organic matter, thereby altering toxicity.	Small underestimation of risk
	Contaminant sensitivity is species-specific. It is not known how the response of the embryo-larval stages of the wood frog (*Rana sylvatica*) compares to that of other amphibian species (i.e., green frog, [*Rana clamitans*] or eastern newts [*Notophthalmus viridescens*]) known to use the ponds for breeding.	From no effect to moderate underestimation
	Overall potential effect on ecological risk	***Up to moderate underestimation***
INSECTIVOROUS WILDLIFE RECEPTORS (TREE SWALLOW AND EASTERN SMALL-FOOTED BAT)		
Measurement endpoint 5.A and 6.A: Food chain modeling.	The metal concentrations in emergent aquatic insects used in the exposure calculations were estimated based on generic sediment-to-benthic invertebrate BAFs. It was possible that benthic invertebrates would take up dissolved COPECs directly from the surface water, even though that uptake route was not evaluated.	Slight underestimation of risk
	The tree swallow and eastern-small footed bat were selected as surrogates for all of the insectivorous wildlife receptors that may feed from the waterways affected by past and present mine-related releases. It was assumed that these two target species represented the receptors on the Site that have ecological or societal value.	Unknown effect on risk for tree swallow; no effect on risk for the bat which is a listed species
	Some of the exposure parameters used in food chain modeling (i.e., body weight, ingestion rates) represented average and species-specific values but were not site-specific.	Minimal effect on risk
	Other exposure parameters (e.g., area use factors, COPEC bioavailability) were conservative values.	large overestimation of risk
	The TRVs were conservative and non-species specific.	Moderate overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs	Small underestimation of risk
	Overall potential effect on ecological risk	***Up to large overestimation***
PISCIVOROUS WILDLIFE RECEPTORS (BELTED KINGFISHER AND MINK)		
Measurement endpoint 7.A and 8.A: Food chain modeling.	The tissue metal concentrations used in the exposure calculations were those measured in whole fish collected from the target waterways.	No effect on risk
	The belted kingfisher and the mink were selected as surrogates for all of the piscivorous wildlife receptors that may feed from the waterways affected by past and present mine-related releases. It was assumed that these two target species represented the receptors on the Site that have ecological or societal value.	Unknown effect on risk
	Some of the exposure parameters used in food chain modeling (i.e., body weight, ingestion rates) represented average and receptor-specific values but were not site-specific.	Minimal effect on risk
	Other exposure parameters (e.g., area use factors, 100% bioavailability of COPECs in fish tissue) were conservative values.	Moderate overestimation of risk
	The TRVs were conservative and non-species specific.	Moderate overestimation of risk
	HQs were only calculated for individual COPECs, without considering the potential for cumulative risk from multiple COPECs	Small underestimation of risk
	Overall potential effect on ecological risk	***Moderate overestimation***

SECTION 8.0: SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

A BERA was performed on the aquatic habitats potentially affected by the Ely Copper Mine Superfund Site, located in Vershire, VT. The Site was used in the 19th and early 20th century for ore mining, ore "roasting", copper smelting, and disposal of waste rock and tailings. Past site investigations showed severe impacts associated with AMD to terrestrial habitats at the Site and to aquatic habitats on and off the Site.

The major aquatic habitats at the Site consist of several small ponds located on the east branch of Ely Brook, and the main stem of Ely Brook itself. Several other Ely Brook tributaries have surface water high in acidity and metals but are too small and/or ephemeral to be considered viable aquatic habitats. The major off-Site aquatic habitats consist of Schoolhouse Brook downstream of the confluence with the main stem of Ely Brook and the EBOR downstream of the confluence with Schoolhouse Brook.

A SLERA performed in 2007 showed the potential for ecological risk to aquatic receptors in all of the aquatic habitats at and downgradient of the Site. This finding prompted the need to proceed with a BERA to further determine the degree and extend of ecological risk in these habitats.

The BERA evaluated the following groups of ecological receptors in one or more of the aquatic habitats:

- Benthic invertebrates
- Water column invertebrates
- Fish
- Amphibians
- Insectivorous birds and mammals
- Piscivorous birds and mammals

8.2 GENERAL CONCLUSIONS OF THE BERA

The general conclusions on the risk associated with the aquatic habitat on- and off-Site are provided in **Attachments 8.1 to 8.8**. These conclusions are summarized below.

8.2.1 Benthic invertebrate community

The potential for ecological risk to the benthic community exposed to Site-related contamination was assessed in all of the aquatic habitats using up to six measurement endpoints (depending on the target habitat), as follows:

- Compare COPEC concentrations in bulk sediment samples to sediment benchmarks (the four ponds, main stem of Ely Brook, Schoolhouse Brook, and the EBOR)
- Compare dissolved COPEC concentrations in sediment pore water samples to surface water benchmarks (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Estimate the bioavailability of divalent metals in sediment based on AVS - SEM (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in two benthic invertebrate species exposed for 96 hours to sediment pore water samples (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in two benthic invertebrate species exposed for 10 and 28 days to bulk sediment samples (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).

- Evaluate the structure and function of the invertebrate community in the field (main stem of Ely Brook, Schoolhouse Brook, and the EBOR).

8.2.1.1 The ponds on the east branch of Ely Brook

Bulk sediment chemistry was the only measurement endpoint available to assess risk to these four aquatic habitats. Severe ecological risk to the benthic invertebrate community was expected in pond 5, based on high Cu concentrations. Ponds 3 and 4 could experience minor ecological risk due to small exceedances of Mn (pond 3) and Cu (pond 4). No risk was expected in pond 2. The reliability of these findings is low because it is based on a single, semi-qualitative LOE.

8.2.1.2 The main stem of Ely Brook

All six measurement endpoints indicated the potential for ecological risk to the benthic invertebrate community in the main stem of Ely Brook. This conclusion was supported by the three "chemical" LOEs (i.e., comparing sediment COPEC levels to benchmarks, comparing pore water COPEC levels to benchmarks, and assessing sediment divalent metal bioavailability based on AVS – SEM) and the three "biological" LOEs (i.e., pore water toxicity testing, bulk sediment toxicity testing, and benthic invertebrate community surveys).

The preponderance of the evidence indicated severe ecological impairment to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

8.2.1.3 Schoolhouse Brook

Five of the six measurement endpoints indicated the potential for ecological risk to the benthic invertebrate community in the reach of Schoolhouse Brook below the confluence with the main stem of Ely Brook. The three "chemical" LOEs (i.e., comparing sediment COPEC levels to benchmarks, comparing pore water COPEC levels to benchmarks, and assessing sediment divalent metal bioavailability based on AVS – SEM) and two of the three "biological" LOEs (i.e., bulk sediment toxicity testing and benthic invertebrate community surveys) resulted in conclusions of risk. The one exception was pore water acute toxicity testing, which did not show toxicity in the two test species after 96 hours of exposure.

The preponderance of the evidence indicated severe ecological impairment to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

8.2.1.4 The EBOR

Five of the six measurement endpoints showed a lack of ecological risk to the benthic invertebrate community in the reach of the EBOR below the confluence with Schoolhouse Brook. Two of the three "chemical" LOEs (i.e., comparing sediment COPEC levels to benchmarks and comparing pore water COPEC levels to benchmarks) and the three "biological" LOEs (i.e., pore water toxicity testing, bulk sediment toxicity testing, and benthic invertebrate community surveys) showed no risk. The one exception was assessing sediment AVS – SEM which indicated the potential for divalent metal bioavailability.

The preponderance of the evidence indicated no significant risk to the benthic invertebrate community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

8.2.2 <u>Water column invertebrate community</u>

The potential for ecological risk to the water column invertebrate community exposed to Site-related contamination was assessed only in the four ponds on the east branch of Ely Brook because they represented the only lentic habitat on or off the Site. One measurement endpoint was used, namely comparing dissolved COPEC concentrations in surface water samples to benchmarks. The results of a second measurement endpoint based on toxicity testing of surface water using the water flea were invalidated because the test did not meet minimum test acceptability criteria.

The one available LOE for this receptor group showed a low potential for ecological risk in ponds 2 and 3 (associated with small exceedances of dissolved Mn in both cases), but a high potential for ecological risk in pond 5 (associated mainly with elevated levels of dissolved Cu). No risk was found to water column invertebrates exposed to surface water in pond 4.

The preponderance of the evidence indicated the potential for low level of ecological risk in ponds 2 and 3, and high level of ecological risk in pond 5. The reliability of this conclusion is low because it is based on a single, semi-qualitative LOE.

8.2.3 <u>Fish</u>

The potential for ecological risk to fish populations exposed to Site-related contamination was assessed using up to four measurement endpoints (note: the ponds on the east branch of Ely Brook were excluded from this evaluation because they did not support fish):

- Compare dissolved COPEC concentrations in surface water samples to surface water benchmarks (main stem Ely brook, Schoolhouse Brook, and the EBOR).
- Measure survival and growth in larval fathead minnows exposed for 10 days to surface water samples (main stem of Ely Brook and Schoolhouse Brook).
- Compare COPEC levels measured in whole fish to CBRs (Schoolhouse Brook and the EBOR).
- Evaluate the structure and function of the fish community in the field (Schoolhouse Brook and the EBOR).

8.2.3.1 The main stem of Ely Brook

A potential for severe ecological risk to fish was identified in the main stem of Ely Brook. This conclusion was supported by one “chemical” LOE (i.e., comparing surface water COPEC to benchmarks) and one “biological” LOE (i.e., surface water toxicity testing). A second “biological” LOE (i.e., evaluating the structure and function of the fish community) could not be used because fish were absent from the main stem of Ely Brook, even though it should be able to support fish. This observation gave indirect evidence of the severe impact of AMD on this habitat

The preponderance of the evidence indicated severe ecological impairment to the fish community in the main stem of Ely Brook in response to AMD. The reliability of this conclusion is high because it is based on multiple lines of evidence, including quantitative biological field data.

8.2.3.2 Schoolhouse Brook

All four measurement endpoints indicated the potential for ecological risk to the fish community in the reach of Schoolhouse Brook below the confluence with the main stem of Ely Brook. The one “chemical” LOE (i.e., comparing surface water COPEC levels to benchmarks) and all three “biological” LOEs (i.e., surface water toxicity testing, fish tissue residue analysis, and fish community surveys) resulted in conclusions of risk. Comparing the fish tissue residues to CBRs provided the weakest evidence in support of risk, presumably because fish with higher tissue residues levels (particularly Cu) died off and would not be available for sampling.

The preponderance of the evidence indicated severe ecological impairment to the fish community in this habitat in response to AMD. The reliability of this conclusion is high because it is based on multiple LOEs, including quantitative biological field data.

8.2.3.3 The EBOR

Two of the three measurement endpoints showed a lack of ecological risk to the fish community in the reach of the EBOR below the confluence with Schoolhouse Brook. The one “chemical” LOE (i.e., comparing surface water COPEC levels to benchmarks) showed a low potential for ecological risk associated with exposures to dissolved silver and zinc (but not Cu). Both “biological” LOEs (i.e., surface water toxicity testing and fish community surveys) showed a lack of risk.

However, the fish surveys provided contradictory results. The fish sample collected from the EBOR just downstream of the confluence with Schoolhouse Brook and at one downgradient location showed a healthy community. However, fish samples collected at two more downstream locations showed degraded communities. More sampling at one of those two locations the following year showed a healthy community. This evidence was interpreted to mean that this apparent impairment was not systemic and may have been related to a unknown sampling bias.

The preponderance of the evidence indicated no significant risk to the fish community in this habitat in response to AMD. The reliability of this conclusion is moderate-low because the “chemical” LOE indicated a potential for ecological risk and the fish community surveys gave contradictory results.

8.2.4 Amphibians

The potential for ecological risk to amphibians exposed to Site-related contamination was assessed only for the four ponds on the east branch of Ely Brook using up to three measurement endpoints (depending on the pond), as follows:

- Compare dissolved COPEC concentrations in surface water samples to published surface water benchmarks (ponds 2 to 5).
- Measure survival and growth in fathead minnow larvae (surrogates for amphibian larval stages) exposed for 7 days to surface water samples (ponds 4 and 5 only).
- Evaluate hatching and survival of wood frog eggs and tadpoles exposed in the field (ponds 4 and 5 only).

Only the first measurement endpoint was assessed in all four ponds. This single “chemical” LOE showed a low potential for ecological risk in ponds 2 and 3 (associated with exceedances of dissolved Mn in both cases), but a high potential for ecological risk in pond 5 (associated mainly with high levels of dissolved Cu). No risk was found to larval amphibians exposed to surface water in pond 4.

The two remaining measurement endpoints were evaluated only in ponds 4 and 5. These two “biological” LOEs identified ecological risk. The surface waters from these two ponds were toxic to fish larvae tested in the laboratory and to tadpoles (but not frog eggs) exposed in the field. The results of the tadpole study were compromised due to unexpected and persistent mortality in the on- and off-Site reference locations. Only the mortality data generated after the first week of tadpole exposure in the field were used semi-qualitatively in the evaluation.

The preponderance of the evidence indicated the aquatic life stages of amphibians experienced low risk in ponds 2 and 3, but high risk in ponds 4 and 5. The reliability of this conclusion is medium because it is based on multiple lines of evidence, including laboratory and field exposures. However, the field exposures using tadpoles only provided partial results.

8.2.5 Insectivorous birds

The potential for ecological risk to insectivorous birds feeding over the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat):

- Estimate the COPEC residues in winged aquatic insects and use food chain modeling to calculate daily doses to tree swallows for comparison to TRVs (Schoolhouse Brook and the EBOR).

8.2.5.1 Schoolhouse Brook

The available measurement endpoint identified the potential for ecological risk to insectivorous birds feeding over Schoolhouse Brook. Cu was the main risk driver in this habitat, although the risk exceedances were relatively small. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

8.2.5.2 The EBOR

The available measurement endpoint identified the potential for ecological risk to insectivorous birds feeding over the EBOR. Cu was the main risk driver in this habitat, although the risk exceedances were small and unlikely to cause severe long-term impairment to this receptor group. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

8.2.6 Insectivorous mammals

The potential for ecological risk to insectivorous mammals feeding over the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat):

- Estimate the COPEC residues in winged aquatic insects and use food chain modeling to calculate daily doses to small-footed bats for comparison to TRVs (Schoolhouse Brook and the EBOR).

8.2.6.1 Schoolhouse Brook

The available measurement endpoint identified a strong potential for ecological risk to insectivorous mammals feeding over Schoolhouse Brook. Cu was the main risk driver in this habitat. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

8.2.6.2 The EBOR

The available measurement endpoint identified the potential for ecological risk to insectivorous mammals feeding over the EBOR. Cu was the main risk driver in this habitat, although the risk was relatively small. The reliability of this conclusion is low because it is based on unmeasured insect tissue residue values which were estimated based on generic biota-to-sediment accumulation factors.

8.2.7 Piscivorous birds and mammals

The potential for ecological risk to piscivorous birds and mammals feeding in the two off-Site waterways was assessed using one endpoint, as follows (note: the four ponds on the east branch of Ely Brook and the main stem of Ely Brook were excluded from this evaluation because they represented too small a feeding habitat and lacked fish):

- Measure the COPEC residues in fish and use food chain modeling to calculate daily doses to belted kingfishers and mink for comparison to avian and mammalian TRVs (Schoolhouse Brook and the EBOR).

8.2.7.1 Schoolhouse Brook

The available measurement endpoint did not identify the potential for ecological risk to piscivorous birds and mammals feeding over Schoolhouse Brook. The reliability of this conclusion is moderate because it is based on measured fish residue values but using simplistic food chain modeling assumptions.

8.2.7.2 The EBOR

The available measurement endpoint did not identify the potential for ecological risk to piscivorous birds and mammals feeding over the EBOR. The reliability of this conclusion is moderate because it is based on measured fish residue values but using simplistic food chain modeling assumptions.

Attachment 8.1: Summary of the evidence for ecological risk at pond 2 on the east branch of Ely Brook					
Receptor Group	**Measurement Endpoint**	**WOE**	**Risk Conclusion**	**Major uncertainties**	**Comments**
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for eco risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailiability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	No comment.
	OVERALL RISK CONCLUSION		***No ecological risk is expected to the benthic invertebrate community in pond 2.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was relatively small (HQ = 4.4) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Only minor ecological risk to the water column invertebrate community is expected in pond 2.***		
Fish	This receptor group was not evaluated for ecological risk in pond 2.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that averse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in pond 2 during the breeding season. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was relatively small (HQ = 4.4) and not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	medium	Measurement endpoint 4.B was not evaluated in pond 2.	--	--
	4.C: Evaluate *in-situ* survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	high	Measurement endpoint 4.C was not evaluated in pond 2.	--	--
	OVERALL RISK CONCLUSION		***A small potential for ecological risk is expected to the embryo-larval stages of amphibians in pond 2.***		
Insectivorous Birds	This receptor group was not evaluated for ecological risk in pond 2.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in pond 2.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in pond 2.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in pond 2.	--	--	--	--

COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk

Attachment 8.2: Summary of the evidence for ecological risk at pond 3 on the east branch of Ely Brook

Receptor Group	Measurement Endpoint	WOE	Risk Conclusion	Major uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailiability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	Manganese had the highest IR CTE effect HQ. The exceedance was small (HQ = 2.5) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		*Minor ecological risk is expected to the benthic invertebrate community in pond 3.*		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was small (HQ = 3.6) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		*Minor ecological risk is expected to the water column invertebrate community in pond 3.*		
Fish	This receptor group was not evaluated for ecological risk in pond 3.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in pond 3 during the breeding season. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was small (HQ = 3.6) and not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	medium	Measurement endpoint 4.B was not evaluated in pond 3.	--	--
	4.C: Evaluate in-situ survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	high	Measurement endpoint 4.C was not evaluated in pond 3.	--	--
	OVERALL RISK CONCLUSION		*Minor ecological risk is expected to the embryo-larval stages of amphibians in pond 3.*		
Insectivorous Birds	This receptor group was not evaluated for ecological risk in pond 3.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in pond 3.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in pond 3.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in pond 3.	--	--	--	--

COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk

Attachment 8.3: Summary of the evidence for ecological risk at pond 4 on the east branch of Ely Brook					
Receptor Group	**Measurement Endpoint**	**WOE**	**Risk Conclusion**	**Major uncertainties**	**Comments**
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailiability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance was small (HQ = 2.2) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk to the benthic invertebrate community is expected in pond 4.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a moderate level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events in early spring and fall. However, the surface water benchmarks were generic and conservative.	No IR CTE chronic HQs exceeded 1.0. Only copper and manganese had chronic IR RME HQ's above 1.0 (6.6 and 1.7, respectively). These relatively small exceedances of a "worst case" exposure scenario are not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk to the water column invertebrates is expected in pond 4.***		
Fish	This receptor group was not evaluated for ecological risk in pond 4.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a moderate level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in pond 4 during the breeding season. However, the surface water benchmarks were generic and conservative.	No IR CTE chronic HQs exceeded 1.0. Only copper and manganese had chronic IR RME HQ's above 1.0 (6.6 and 1.7, respectively). These small exceedances of a "worst case" exposure scenario are not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	medium	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected over three days in late June and did not represent the full exposure potential during the amphibian breeding season (May-June). Metal precipitation in the test water may also have decreased toxicity.	Only 20% of the fathead minnow neonates survived the seven-day exposure to pond 4 surface water.
	4.C: Evaluate *in-situ* survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	high	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the physical and chemical conditions inside the Nytex cages may have caused some of the dissolved metals to precipitate out or bind to organic matter. On the other hand, the exposure was realistic (*in-situ* in early May) and used a local amphibian species.	Hatching success was no different from that observed in the reference ponds. However, survival of wood frog tadpoles exposed for eight days to pond 4 surface water was poor.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the embryo-larval stages of amphibians is expected in pond 4.***		
Insectivorous Birds	This receptor group was not evaluated for ecological risk in pond 4.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in pond 4.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in pond 4.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in pond 4.	--	--	--	--

COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk

Attachment 8.4: Summary of the evidence for ecological risk at pond 5 on the east branch of Ely Brook

Receptor Group	Measurement Endpoint	WOE	Risk Conclusion	Major uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailiability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance equaled 23 and was expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community is expected in pond 5.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the benchmarks were generic and conservative.	Copper had the highest IR CTE chronic HQ. The exceedance equaled 45 and was expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the water column invertebrate community is expected in pond 5.***		
Fish	This receptor group was not evaluated for ecological risk in pond 5.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in pond 5 during the breeding season. However, the surface water benchmarks were generic and conservative.	Copper had the highest IR CTE chronic HQ. The exceedance equaled 45 and was expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	medium	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected over three days in late June and did not represent the full exposure potential during the amphibian breeding season (May-June). Metal precipitation in the test water may also have decreased toxicity.	None of the fathead minnow neonates survived the seven-day exposure to pond 5 surface water.
	4.C: Evaluate *in-situ* survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	high	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the physical and chemical conditions inside the Nytex cages could have caused some of the dissolved metals to precipitate out or bind to organic matter. On the other hand, the exposure was realistic (*in-situ* in early May) and used a local amphibian species.	Hatching success was no different from that observed in the reference ponds. However, 100% of the tadpoles died within a few days of hatching.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the embryo-larval stages of amphibians is expected in pond 5.***		
Insectivorous Birds	This receptor group was not evaluated for ecological risk in pond 5.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in pond 5.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in pond 5.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in pond 5.	--	--	--	--

COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk

Attachment 8.5: Summary of the evidence for ecological risk in the main stem of Ely Brook

Receptor Group	Measurement Endpoint	WOE	Risk Conclusion	Major uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailiability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Cu had the highest IR CTE effect HQ. The exceedance equaled 19 and was expected to cause severe impairment.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest. Acidity may also become an issue during high flow.	Mn and Cu had the highest IR CTE chronic HQs. The exceedances equaled 6.4 and 4.7, respectively, and were expected to cause some impairment.
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	low	It was concluded that adverse effects were possible because SEM exceeded AVS in all nine sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples.	medium	It was concluded that adverse effects were present for sensitive species of the benthic invertebrate community.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest. Acidity may also become an issue during high flow.	All three pore water samples were acutely toxic to the amphipod, but none was toxic to the chironomid fly larvae (*C. tentans*).
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.	medium	It was concluded that adverse effects were present for sensitive species of the benthic invertebrate community.	The potential for ecological risk may be moderately overestimated because (1) the sediment samples were collected from depositional areas which do not represent the whole stream, and (2) conditions in the test beakers are more static than those present in native substrate.	Two of the three samples were toxic to both species. A third sample had the highest metal levels and lowest pH, but was non-toxic. The hard water used for the daily water renewals appeared to have increased pH and caused all dissolved metals to precipitate out.
	1.F: Evaluate the structure and function of the benthic invertebrate community.	high	It was concluded that the benthic invertebrate community was severely impaired in the main stem of Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	The health of the benthic community did not improve between 1987 and 2006.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community was present in the main stem of Ely Brook.***		
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.		--	--	No comment.
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks	low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately underestimated because the surface water benchmarks did not account for the effects of potential low pH episodes during certain times of the year.	Cu and Al had the highest IR CTE chronic HQs. The exceedances equaled 281and 68, respectively, and were expected to cause severe impairment.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be be moderately underestimated because (1) the samples were collected in late June of 2006 when chemical conditions were less severe than during high-flow events, (2) a single fish species was tested for a relatively short period of time, and (3) COPEC levels may have changed in the renewal samples due to metal precipitation.	The one surface water sample collected from the main stem of Ely Brook for toxicity testing resulted in 100% mortality in fathead minnow neonates after seven days of exposure.
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	medium	Measurement endpoint 3.C was not evaluated because no fish live in the main stem of Ely Brook.	--	No comment.
	3.D: Evaluate the structure and function of the fish community.	high	Measurement endpoint 3.D was not evaluated because no fish live in the main stem of Ely Brook.	--	The lack of fish in the main stem of Ely Brook indicates the presence of high toxicity in its surface waters.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the fish community was present in the main stem of Ely Brook.***		

Attachment 8.5: Summary of the evidence for ecological risk in the main stem of Ely Brook					
Receptor Group	**Measurement Endpoint**	**WOE**	**Risk Conclusion**	**Major uncertainties**	**Comments**
Amphibians	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Insectivorous Birds	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--

AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals

Attachment 8.6: Summary of the evidence for ecological risk in Schoolhouse Brook					
Receptor Group	**Measurement Endpoint**	**WOE**	**Risk Conclusion**	**Major uncertainties**	**Comments**
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailiability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance equaled 1.9 and was not expected to cause severe impairment by itself.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest.	The potential for ecological risk was associated mainly with thallium, which had the only IR CTE chronic HQ > 1.0 (HQ = 6.7).
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	low	It was concluded that risk was possible because SEM exceeded AVS in all ten sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples.	medium	It was concluded that adverse effects were not present because the pore water samples collected from Schoolhouse brook were not acutely toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest.	The evidence showed that conditions in the substrate were suitable for sensitive benthic invertebrates under short-term exposures at the time of pore water sampling.
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.	medium	It was concluded that adverse effects were present because all four bulk sediment samples were toxic to both *H. azteca* and *C. tentans*.	The potential for ecological risk may be moderately overestimated because (1) the sediment samples were collected from depositional areas which do not represent the whole stream, and (2) conditions in the test beakers were more static than those present in native substrate.	--
	1.F: Evaluate the structure and function of the benthic invertebrate community.	high	It was concluded that the benthic invertebrate community was severely impaired in Schoolhouse Brook below the confluence with Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	The health of the benthic community did not improve appreciably between 1987 and 2006.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community was present in Schoolhouse Brook.***		
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in Schoolhouse Brook.		--	--	--
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be be moderately underestimated because the surface water benchmarks did not account for the effects of potential low pH episodes during certain times of the year.	Copper had an IR CTE effect HQ equal to 7.8. This exceedance was likely to cause impairment to the local fish community.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	medium	It was concluded that adverse effects were present for a sensitive fish lifestage.	The potential for ecological risk was expected to be be moderately underestimated because (1) the samples were collected in late June of 2006 when chemical conditions were less severe than during high-flow events, (2) a single fish species was tested for a relatively short period of time, and (3) COPEC levels may have changed in the renewal samples due to metal precipitation.	Fish survival was significantly lower at all four sampling locations in Schoolhouse Brook.
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately overestimated because the fish tissue CBRs were quite conservative. On the other hand, cumulative risk was not considered and fish with higher residue levels may have been absent from the stream because they died out.	Cu was the only COPEC with an IR CTE effect HQ > 1.0. The Cu exceedances were small (HQ = 2.5 for brook trout and 1.3 for dace) and not expected to cause impairment by themselves. However, fish with higher tissue residues could have been eliminated from the local population.
	3.D: Evaluate the structure and function of the fish community.	high	It was concluded that the fish community was severely impaired in the entire section of Schoolhouse Brook below the confluence with Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the fish community represents a chronic response of chemical conditions integrated over time.	--
	OVERALL RISK CONCLUSION		***Severe ecological risk to the fish community was present in Schoolhouse Brook.***		

Attachment 8.6: Summary of the evidence for ecological risk in Schoolhouse Brook

Receptor Group	Measurement Endpoint	WOE	Risk Conclusion	Major uncertainties	Comments
Amphibians	This receptor group was not evaluated for ecological risk in Schoolhouse Brook.	--	--	--	--
Insectivorous Birds	5.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	medium-low	It was concluded, with a high level of confidence, that adverse effects to insectivorous birds feeding over Schoolhouse Brook were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu and Se were the only COPECs with an IR RME and CTE effect HQ > 1.0. Both exceedances were relatively small (Cu CTE HQ = 6.4 and Se CTE HQ = 2.5) and would not be expected to cause severe impairment by themselves.
	OVERALL RISK CONCLUSION		*The potential exists for some ecological risk to insectivorous birds feeding on insects from Schoolhouse Brook.*		
Insectivorous Mammals	6.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	medium-low	It was concluded, with a high level of confidence, that adverse effects to insectivorous mammals feeding over Schoolhouse Brook were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR RME and CTE effect HQ > 1.0. The CTE effect exceedance was large (HQ = 24) and could cause severe impairment.
	OVERALL RISK CONCLUSION		*The potential exists for severe ecological risk to insectivorous mammals feeding on insects from Schoolhouse Brook.*		
Piscivorous Birds	7.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these values to TRVs.	medium	It was concluded, with a moderate level of confidence, that adverse effects to piscivorous birds were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	No COPECs had an IR CTE effect HQ > 1.0.
	OVERALL RISK CONCLUSION		*Ecological risk is not expected to piscivorous birds feeding on fish from Schoolhouse Brook.*		
Piscivorous Mammals	8.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these doses to TRVs.	medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous mammals were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	No COPECs had an IR CTE effect HQ > 1.0.
	OVERALL RISK CONCLUSION		*Ecological risk is not expected to piscivorous mammals feeding on fish from Schoolhouse Brook.*		

AUF = area use factor
AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals
TRV = toxicity reference value

Attachment 8.7: Summary of the evidence for ecological risk in the east branch of the Ompompanoosuc River (EBOR)					
Receptor Group	**Measurement Endpoint**	**WOE**	**Risk Conclusion**	**Major uncertainties**	**Comments**
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	No COPECs had IR RME and IR CTE effects HQs > 1.0.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks	low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest.	No COPECs had IR RME and IR CTE chronic HQs > 1.0.
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	low	It was concluded that risk was possible because SEM exceeded AVS in all five sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples	medium	It was concluded that adverse effects were not present because the pore water sample collected from the EBOR for testing was not acutely toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest.	Only one pore water sample was tested for toxicity. The evidence showed that conditions in the substrate were suitable for sensitive benthic invertebrates under short-term exposures at the time of pore water sampling.
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples	medium	It was concluded that adverse effects were unlikely because the bulk sediment sample collected from the EBOR for testing was not toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately overestimated because (1) the sediment sample was collected from a depositional area which may not represent the whole stream, and (2) conditions in the test beakers were more static than those present in native substrate.	The conclusion of no adverse effect is based on testing a single bulk sediment sample collected in the EBOR about 0.5 miles below the confluence with Schoolhouse Brook. An effect might have been detected if samples had been collected closer to the confluence.
	1.F: Evaluate the structure and function of the benthic invertebrate community	high	It was concluded that the benthic invertebrate community was not impaired in the EBOR. Conditions stayed stable between 2005 and 2006.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to the benthic invertebrate community in the EBOR.***		
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in the EBOR.		--	--	--
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks	low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be slightly over estimated because the surface water benchmarks are generic, conservative values.	The high levels of dissolved silver (IR CTE chronic HQ = 8.0) and zinc (IR CTE chronic HQ = 6.5) were likely to impair the local fish community.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	medium	This measurement endpoint was not evaluated in the EBOR	--	--
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were unlikely.	The potential for ecological risk was expected to be moderately overestimated because the fish tissue CBRs were quite conservative. On the other hand, cumulative risk was not considered and fish with higher residue levels may have been absent from the stream because they died out.	All of the IR RME and CTE effect HQs for brook trout and blacknose dace fell below 1.0
	3.D: Evaluate the structure and function of the fish community	high	It was concluded that the fish community was probably not impaired in the EBOR.	The potential for ecological risk was expected to be as reported. The structure of the fish community represents a chronic response of chemical conditions integrated over time.	This conclusion is weakened by the fact that the fish community response in the EBOR was not consistent over space (different sampling locations in the same year) or over time (same sampling location over different years), in part due to a possible sampling bias.
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to the fish community in the EBOR.***		

Attachment 8.7: Summary of the evidence for ecological risk in the east branch of the Ompompanoosuc River (EBOR)					
Receptor Group	Measurement Endpoint	WOE	Risk Conclusion	Major uncertainties	Comments
Amphibians	This receptor group was not evaluated for ecological risk in the EBOR.	--	--	--	--
Insectivorous Birds	5.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs	medium-low	It was concluded, with a high level of confidence, that adverse effects to insectivorous birds were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR CTE effect HQ > 1.0 (HQ = 1.6). This relatively small exceedance would not be expected to cause severe impairment by itself to insectivorous birds.
	OVERALL RISK CONCLUSION		***The potential exists for minor ecological risk to insectivorous birds feeding on insects from the EBOR.***		
Insectivorous Mammals	6.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs	medium-low	It was concluded, with a high level of confidence, that adverse effects to insectivorous mammals were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR CTE effect HQ > 1.0 (HQ = 5.9). This exceedance has the potential to cause some impairment to insectivorous mammals.
	OVERALL RISK CONCLUSION		***The potential exists for ecological risk to insectivorous mammals feeding on insects from the EBOR.***		
Piscivorous Birds	7.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these values to TRVs	medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous birds were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous birds feeding on fish caught in the EBOR***		
Piscivorous Mammals	8.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these doses to TRVs	medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous mammals were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous mammals feeding on fish caught in the EBOR***		

AUF = area use factor
AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals
TRV = toxicity reference value

SECTION 9.0: REFERENCES

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